# CHICOPEE RIVER WATERSHED

## BARRE FALLS DAM

## CONANT BROOK DAM

MASSACHUSETTS

# CONNECTICUT RIVER BASIN

# MASTER MANUAL OF WATER CONTROL

## APPENDIX G

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

JANUARY 1979

407-423

CONNECTICUT RIVER BASIN
MASTER MANUAL
WATER CONTROL

APPENDIX G

CHICOPEE RIVER WATERSHED
BARRE FALLS DAM
CONANT BROOK DAM
MASSACHUSETTS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

JUNE 1964
REVISED JANUARY 1979

# PREFACE

The Chicopee River watershed has a drainage area of 721 square miles and is located in central Massachusetts. The flood control system for the watershed described in this manual consists of Barre Falls Dam in Barre, Conant Brook Dam in Monson and five local protection projects. The five local protection projects are located in Ware, West Warren, Palmer (Three Rivers), Chicopee Falls and Chicopee.

This Appendix of the Connecticut River Master Manual of Water Control includes a description of the watershed, hydrologic, climatological and flood data, together with project descriptions and regulation procedures for Corps reservoirs. In addition to setting forth a method of water control, the manual will serve as a reference source for future studies.

The manual is divided into seven chapters: Introduction, Management, Hydrometeorology, Communications, Hydrologic Forecasts, Reservoir Regulation and Hydrologic Equipment. The setup of chapters allows the reader to obtain desired general background information on any particular aspect of each project.

Pertinent data on the hydrologic information of the Chicopee River watershed, Barre Falls Dam and Conant Brook Dam are shown on pages i, ii, iii, respectively, at the front of the manual.

The chapter on reservoir regulation contains detailed procedures and information necessary for regulating the protective works to provide protection for downstream communities on the Ware, Chicopee and Connecticut Rivers.

CONNECTICUT RIVER BASIN

MASTER MANUAL
OF
WATER CONTROL

| Appendix | Watershed | Reservoir | Status |
|---|---|---|---|
| Master Manual | Connecticut River | | Started |
| A | Ompompanoosuc R. | Union Village | Completed 1950 (Revised 1971) |
| B | Ottauquechee River | North Hartland | Completed 1969 |
| C | Black River | North Springfield | Completed 1968 |
| D | West River | Ball Mountain<br>Townshend | Completed 1965 (Revised 1973) |
| E | Ashuelot River | Surry Mountain<br>Otter Brook | Completed 1962 (Revised 1972) |
| F | Millers River | Birch Hill<br>Tully | Completed 1950 (Revised 1974) |
| G | Chicopee River | Barre Falls<br>Conant Brook | Completed 1964 (Revised 1979) |
| H | Westfield River | Knightville<br>Littleville | Completed 1967 (Revised 1978) |
| I | Farmington River | Colebrook River<br>Mad River<br>Sucker Brook | Completed 1970 |

MANUAL OF WATER CONTROL
CHICOPEE RIVER WATERSHED
MASSACHUSETTS

APPENDIX G

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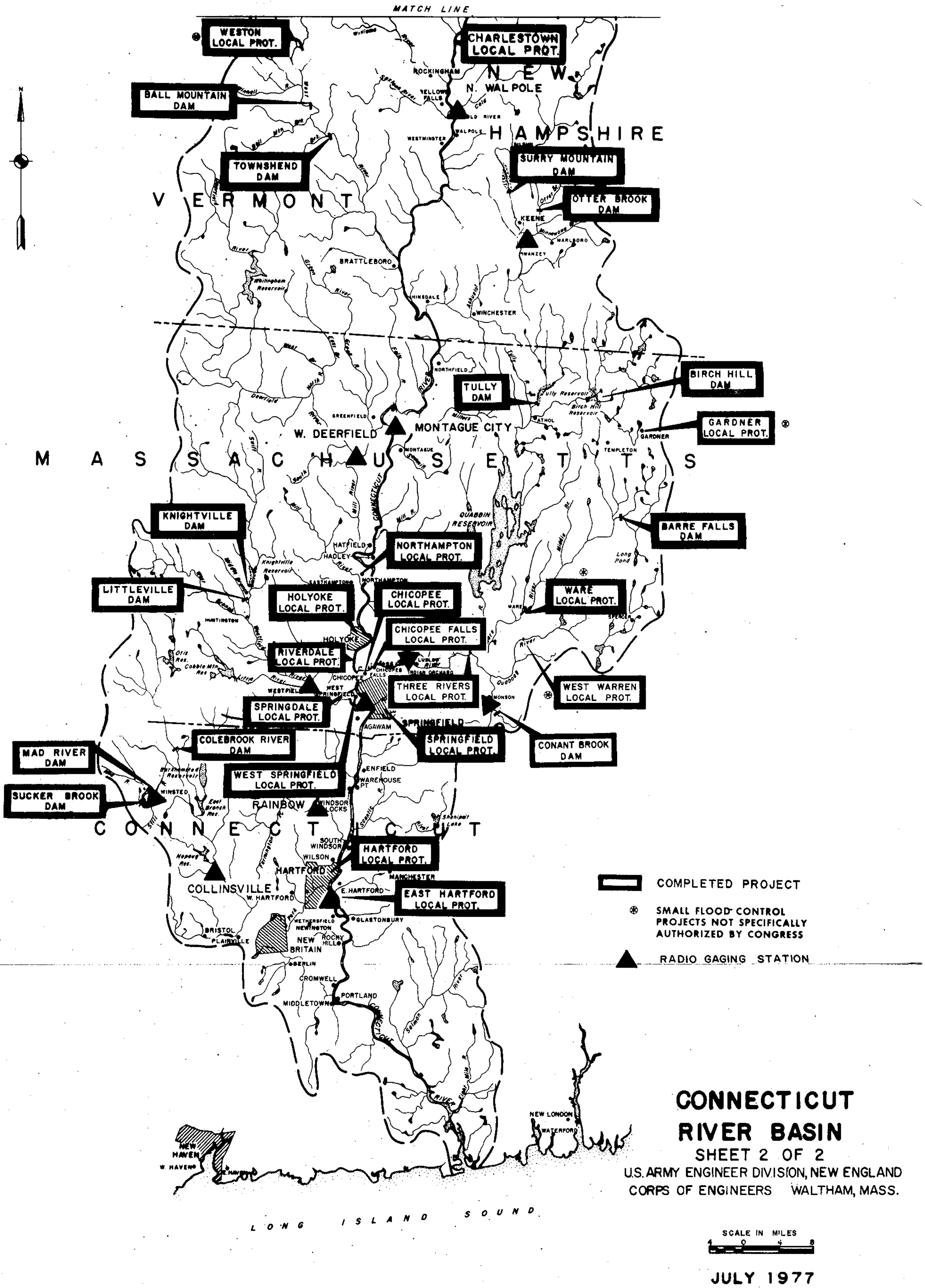
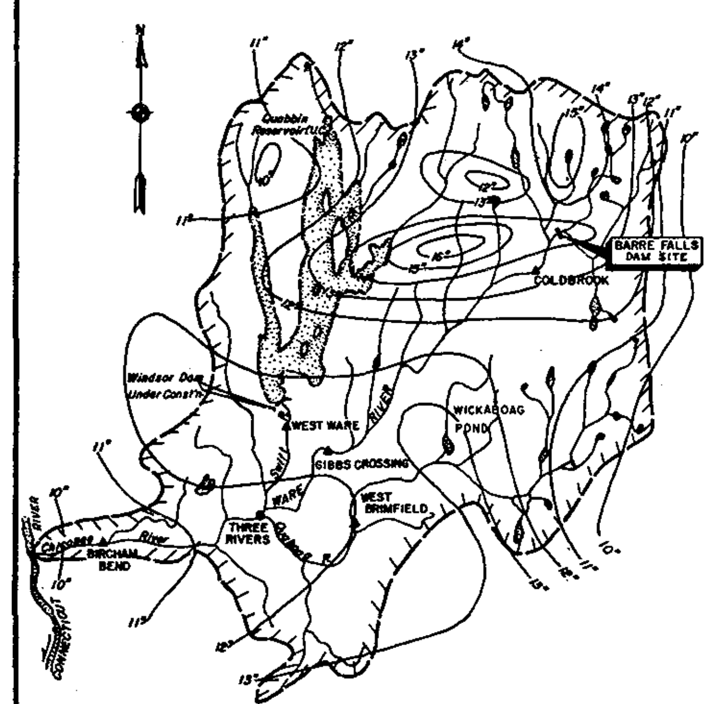
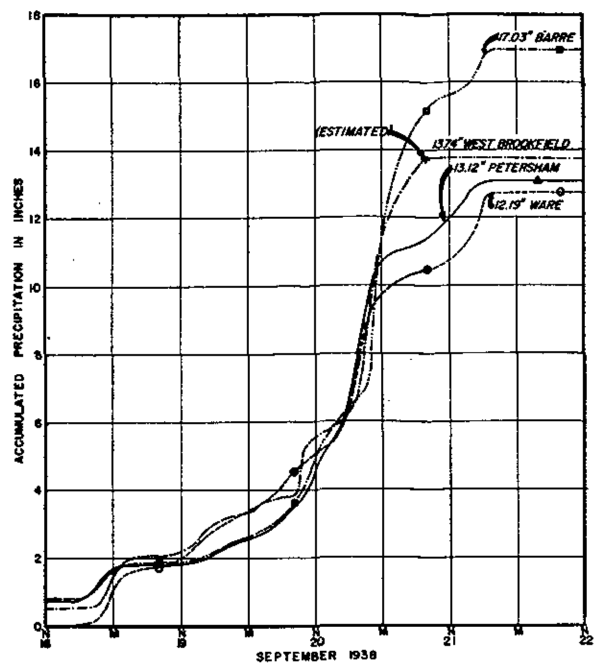

MATCH LINE
WESTON LOCAL PROT.
CHARLESTOWN LOCAL PROT.
BALL MOUNTAIN DAM
NEW HAMPSHIRE
N. WALPOLE
TOWNSHEND DAM
SURRY MOUNTAIN DAM
OTTER BROOK DAM
VERMONT
KEENE
BRATTLEBORO
HINSDALE
WINCHESTER
NORTHFIELD
BIRCH HILL DAM
TULLY DAM
GARDNER LOCAL PROT.
W. DEERFIELD
MONTAGUE CITY
MASSACHUSETTS
QUABBIN RESERVOIR
KNIGHTVILLE DAM
BARRE FALLS DAM
NORTHAMPTON LOCAL PROT.
LITTLEVILLE DAM
HOLYOKE LOCAL PROT.
CHICOPEE LOCAL PROT.
WARE LOCAL PROT.
CHICOPEE FALLS LOCAL PROT.
RIVERDALE LOCAL PROT.
THREE RIVERS LOCAL PROT.
WEST WARREN LOCAL PROT.
SPRINGDALE LOCAL PROT.
SPRINGFIELD
SPRINGFIELD LOCAL PROT.
CONANT BROOK DAM
COLEBROOK RIVER DAM
MAD RIVER DAM
WEST SPRINGFIELD LOCAL PROT.
SUCKER BROOK DAM
RAINBOW
CONNECTICUT
HARTFORD LOCAL PROT.
HARTFORD
COLLINSVILLE
EAST HARTFORD LOCAL PROT.
NEW BRITAIN
MIDDLETOWN
NEW LONDON
NEW HAVEN
LONG ISLAND SOUND
COMPLETED PROJECT
SMALL FLOOD CONTROL PROJECTS NOT SPECIFICALLY AUTHORIZED BY CONGRESS
RADIO GAGING STATION
CONNECTICUT RIVER BASIN
SHEET 2 OF 2
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.
SCALE IN MILES
JULY 1977

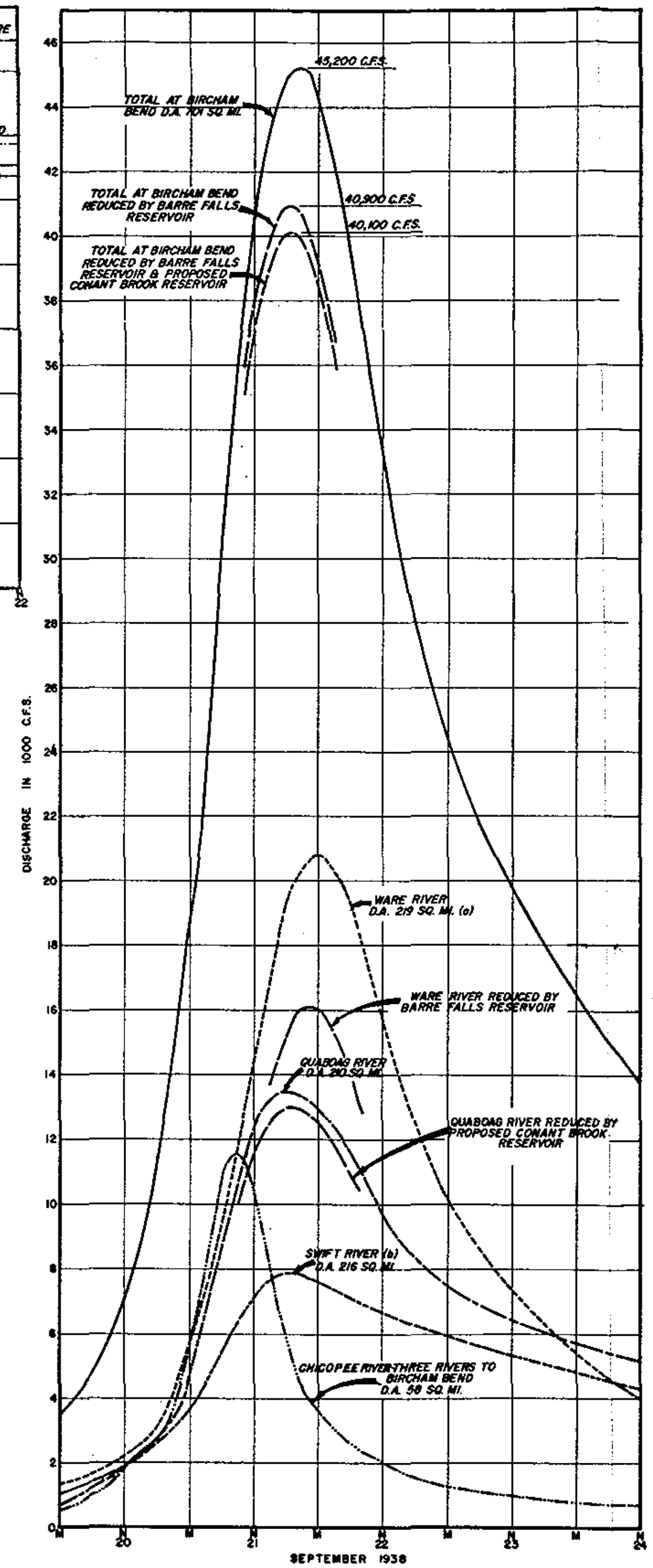
PLATE G-2




**ISOHYETAL MAP**
SEPTEMBER 17-22 1938 STORM
CHICOPEE RIVER BASIN
SCALE IN MILES

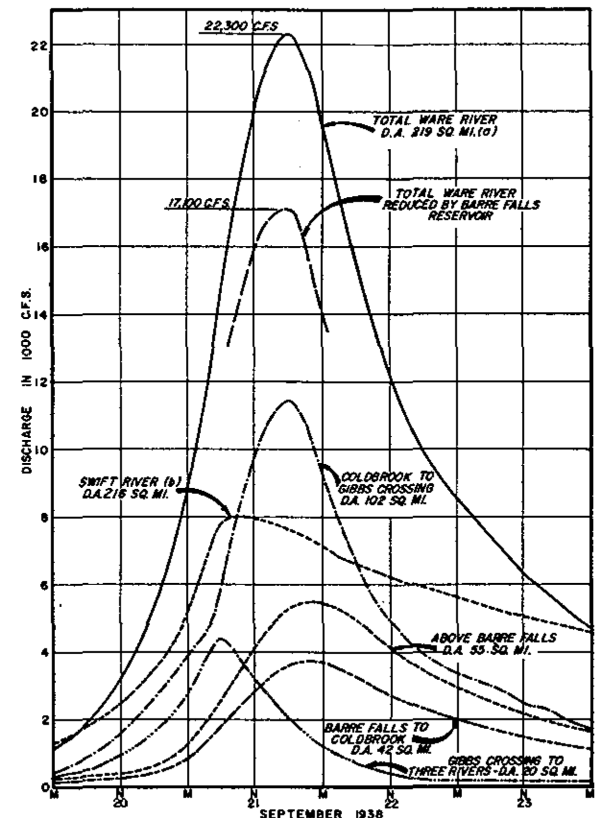



**PRECIPITATION MASS CURVES**

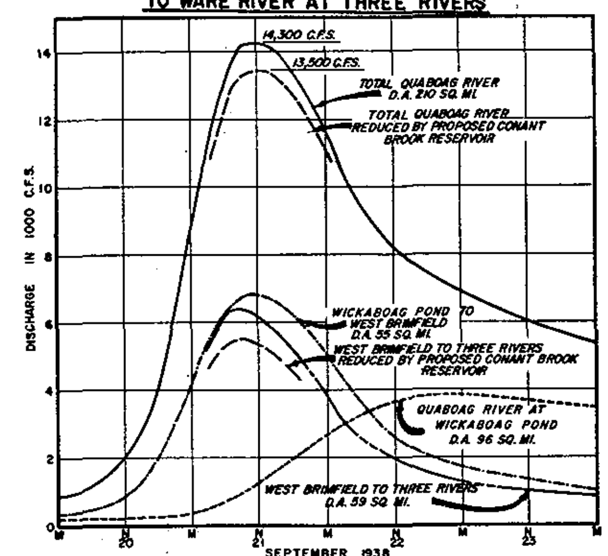



**COMPONENT CONTRIBUTIONS TO CHICOPEE RIVER AT BIRCHAM BEND**

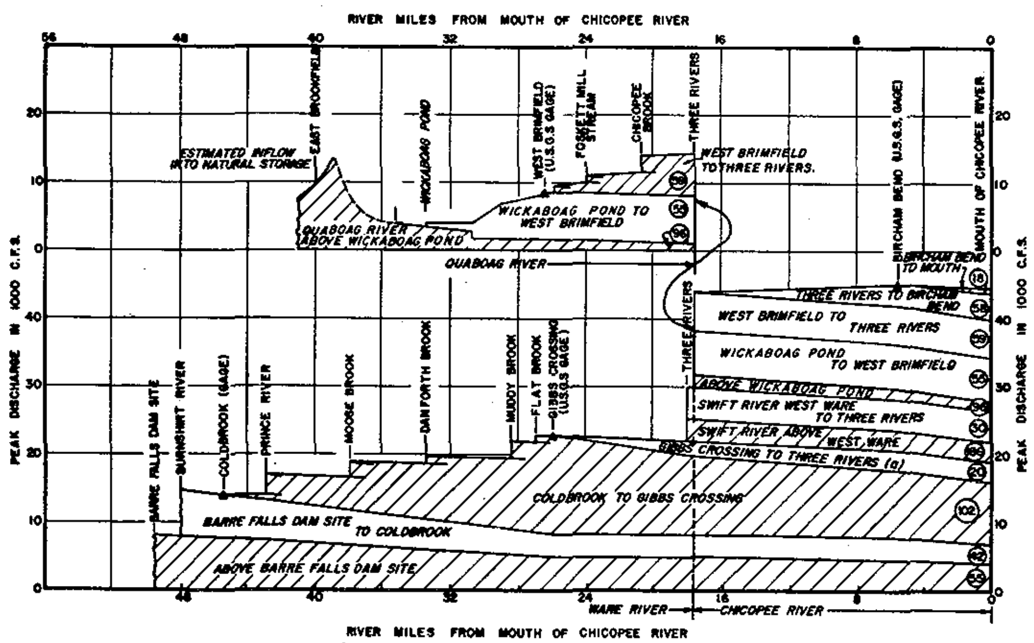
NOTES:
- U.S.G.S. Gaging Station
- Denotes drainage area in Sq. Mi.
- (a) Exclusive of Swift River
- (b) Swift River affected by Quabbin Reservoir under construction at time of flood




**COMPONENT CONTRIBUTIONS TO WARE RIVER AT THREE RIVERS**




**COMPONENT CONTRIBUTIONS TO QUABOAG RIVER AT THREE RIVERS**




**NATURAL PEAK DISCHARGE PROFILE AND TRIBUTARY CONTRIBUTIONS**

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY M.W.B. | CK. BY R.M.

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN

SEPTEMBER 1938 FLOOD

CHICOPEE RIVER, MASSACHUSETTS

CHIEF, HYD. & HYD. SECTION
SUBMITTED BY
CHIEF, PLANN. & ENG'G. BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
COL. C.E., DEPUTY DIVISION ENGINEER
DATE AUG. 1959

TO ACCOMPANY REPORT DATED: 18 SEPTEMBER 1959
SCALE AS SHOWN
DRAWING NUMBER CT-1-5611
SHEET 1 OF 1

## LIST OF PERTINENT DATA SHEETS



## LIST OF TABLES

## LIST OF PLATES

# PERTINENT DATA
# CHICOPEE RIVER WATERSHED
# HYDROLOGIC INFORMATION

## DRAINAGE AREA

| | Square Miles |
|---|---|
| Mainstem - Chicopee River | |
| Chicopee River at Three Rivers | 688 |
| Broad Brook at mouth | 15 |
| Twelve Mile Brook at mouth | 14 |
| Chicopee River at Indian Orchard | 703 |
| Fuller Brook at mouth | 14 |
| Chicopee River at mouth | 721 |
| Tributaries | |
| Ware River | |
| East Branch | 38 |
| West Branch | 16 |
| Ware River at Barre Falls Dam | 55 |
| Burnshirt River at mouth | 31 |
| Ware River at Coldbrook (MDC Intake) | 97 |
| Prince River at mouth | 14 |
| Ware River at Barre Plains (Rte 32 Hwy Bridge) | 115 |
| Moose Brook at mouth | 10 |
| Ware River at Ware (Ware Ind. Co. Dam) | 170 |
| Muddy Brook at mouth | 19 |
| Ware River at Gibbs Crossing (USGS Gage) | 199 |
| Swift River at Quabbin Reservoir | 186 |
| Swift River at mouth | 216 |
| Jabish Brook at mouth | 19 |
| Ware River at mouth of the Swift River | 216 |
| Ware River at the mouth | 435 |
| Quaboag River | |
| Sevenmile River at mouth | 41 |
| Fivemile River at mouth | 24 |
| Quaboag River at West Brookfield | 96 |
| Quaboag River at West Warren (W. Warren Ind. Co.) | 143 |
| Mill Brook at mouth | 14 |
| Chicopee Brook at mouth | 16 |
| Conant Brook at mouth | 9 |
| Quaboag River at mouth of Chicopee Brook | 180 |
| Quaboag River at Palmer | 203 |
| Quaboag River at mouth | 210 |

| Precipitation | Barre Falls Dam Massachusetts (Inches) | Chicopee River @ Ware, Massachusetts (Inches) | Westover Field Massachusetts (Inches) |
|---|---|---|---|
| Mean Annual | 39.4 | 44.7 | 44.9 |
| Maximum Annual | 53.6 (1975) | 60.0 (1955) | 53.4 (1955) |
| Minimum Annual | 26.2 (1965) | 26.4 (1965) | 34.3 (1957) |
| Years of Record (through 1976) | 18 | 49 | 22 (Discontinued after 1963) |

## WATER EQUIVALENT IN SNOW COVER
(Based on Corps of Engineers Surveys 1958-1978)

| | Mean (inches) | Maximum (inches) | Minimum (inches) |
|---|---|---|---|
| 1 February | 2.2 | 4.6 | 0.0 |
| 15 February | 2.9 | 6.2 | 0.0 |
| 1 March | 3.1 | 6.4 | 0.0 |
| 15 March | 2.7 | 6.1 | 0.0 |
| 1 April | 1.2 | 4.1 | 0.0 |
| 15 Arpil | 0.1 | 0.7 | 0.0 |

| USGS GAGES | Drainage Area (sq. mi.) | Tributary | Period of Record |
|---|---|---|---|
| Ware River near Barre | 55.0 | Ware | 1946 - Present |
| Ware River at Coldbrook | 96.8 | Ware | 1928 - Present |
| Ware River at Gibbs Crossing | 199.9 | Ware | 1912 - Present |
| Hop Brook near New Salem | 3.4 | Swift | 1947 - Present |
| E. Branch Swift River near Hardwick | 43.7 | Swift | 1937 - Present |
| Swift River at West Ware | 188.0 | Swift | 1910 - Present |
| Sevenmile River near Spencer | 8.6 | Quaboag | 1960 - Present |
| Quaboag River at West Brimfield | 151.0 | Quaboag | 1909 - Present |
| Chicopee River at Indian Orchard | 688.0 | Chicopee | 1939 - Present |
| Chicopee River at Bircham Bend | 703.0 | Chicopee | 1928 - 1938 |

## PEAK FLOWS

Chicopee River at Indian Orchard, Mass.

| Date | CFS | CSM |
|---|---|---|
| 21 Sep 1938 | 45,200 | 66 |
| 19 Aug 1955 | 40,500 | 59 |
| 19 Mar 1936 | 20,400 | 30 |

Swift River at Ware, Mass.

| Date | CFS | CSM |
|---|---|---|
| 19 Mar 1936 | 7,590 | 40 |
| 22 Sep 1938 | 5,540 | 29 |

Quaboag River at W. Brimfield, Mass.

| Date | CFS | CSM |
|---|---|---|
| 19 Aug 1955 | 12,800 | 85 |
| 21 Sep 1938 | 8,470 | 56 |
| 19 Mar 1936 | 3,620 | 24 |

Ware River at Gibbs Crossing, Mass.

| Date | CFS | CSM |
|---|---|---|
| 21 Sep 1938 | 22,700 | 114 |
| 19 Aug 1955 | 12,200 | 61 |
| 19 Mar 1936 | 11,200 | 56 |

## ANNUAL RUNOFF*

Chicopee River nr Indian Orchard, Mass.

| | CFS | Inches | Year |
|---|---|---|---|
| Mean | 901 | 18 | (50 yrs) |
| Maximum | 1952 | 39 | 1966 |
| Minimum | 376 | 7.5 | 1938 |

Quaboag River nr W. Brimfield, Mass.

| | CFS | Inches | Year |
|---|---|---|---|
| Mean | 241 | 22 | (65 yrs) |
| Maximum | 430 | 39 | 1938 |
| Minimum | 104 | 9.4 | 1930, 65 |

Swift River nr Ware, Mass.

| | CFS | Inches | Year |
|---|---|---|---|
| Mean | 188 | 14 | (65 yrs) |
| Maximum | 497 | 36 | 1938 |
| Minimum | 31 | 2.3 | 1945 |

Ware River nr Gibbs Crossing

| | CFS | Inches | Year |
|---|---|---|---|
| Mean | 288 | 20 | (66 yrs) |
| Maximum | 581 | 40 | 1938 |
| Minimum | 105 | 7.2 | 1965 |

*Through Water Year 1977

## FLOOD ROUTING COEFFICIENTS

| Reach | Routing Coefficient | River Miles Between Points |
|---|---|---|
| Barre Falls to Coldbrook | 3/1 - 3 hr. | 4.2 |
| Coldbrook to Barre Plains | 3/1 | 3.3 |
| Barre Plains to Gibbs Crossing | 5/3 | 17.2 |
| Gibbs Crossing to Three Rivers | 3/1 | 8.8 |
| Conant Brook to Three Rivers | 4/1 | 28.0 |
| Three Rivers to Indian Orchard | 3/1 | 10.8 |
| Indian Orchard to Mouth of Chicopee | 3/1 | 7.2 |

| HIGH FLOW TRAVEL TIMES | Total Hours From Barre Falls Dam |
|---|---|
| Coldbrook | 3-4 |
| Barre Plains | 5-7 |
| Gibbs Crossing | 15-16 |
| Three Rivers | 18-20 |
| Indian Orchard | 21 |
| Mouth of Chicopee | 22-26 |

# PERTINENT DATA
# BARRE FALLS DAM

| | |
|---|---|
| LOCATION | Ware River; Barre, Massachusetts |
| DRAINAGE AREA | 55 Square Miles |
| STORAGE USES | Flood Control |

RESERVOIR STORAGE

| | Elevation (ft msl) | Stage (ft) | Area (acres) | Capacity Acre-Feet | Capacity Inches on Drainage Area |
|---|---|---|---|---|---|
| Inlet Elevation | 761 | 0 | 0 | 0 | 0 |
| Spillway Crest | 807 | 46 | 1,400 | 24,000 | 8.2 |
| Maximum Surcharge | 825 | 64 | 2,950 | 63,000 | 21.5 |
| Top of Dam | 830 | 69 | - | - | - |

EMBANKMENT FEATURES

| | Main Dam | Dikes |
|---|---|---|
| Type | Rolled earth fill with rock protection | 3 |
| Length (feet) | 885 | 3,215 (total) |
| Top Width (feet) | 25 | 15 |
| Top Elev. (ft msl) | 830 | 830 |
| Max. Height (ft) | 69 | 48 |

SPILLWAY

| | |
|---|---|
| Location | Right abutment of the dam |
| Type | Uncontrolled ogee weir, chute spillway in rock |
| Crest Length (feet) | 60 |
| Crest Elev. (ft msl) | 807 |
| Max. Surcharge (ft) | 18.0 |
| Maximum Discharge Capacity (cfs) | 16,300 |

SPILLWAY DESIGN FLOOD

| | Original Design | 1973 Studies |
|---|---|---|
| Peak Inflow (cfs) | 68,300 | 61,000 |
| Peak Outflow (cfs) | 16,300 (spillway only) | 14,800 |
| Volume Runoff (Ac. Ft.) | 62,500 | 55,500 |

OUTLET WORKS

| | |
|---|---|
| Type | Horseshoe conduit |
| Tunnel Inside | 9'8" diameter |
| Tunnel Length (ft) | 250 |
| Service Gate Type | Electrically operated gear driven sluice |
| Size | Two 4.5' wide x 9.0' high |
| Emergency Gate Type | None |
| Downstream Channel Capacity (cfs) | 1,000 |
| Discharge Cap. at Spillway Crest (cfs) | 3,000 |

LAND ACQUISITION

| | |
|---|---|
| Guide Taking Line | 815 ft msl (both fee and easement) |
| Fee (acres) | 557 |
| Easement (acres) | 1,869 |

MAXIMUM POOL OF RECORD

| | |
|---|---|
| Date | April 1960 |
| Stage (feet) | 36.5 |
| Elevation (ft msl) | 797.9 |
| Percent Full | 50 |

UNIT RUNOFF

| | |
|---|---|
| One Inch Runoff (Ac. Ft.) | 2,935 |

OPERATING TIME

| | |
|---|---|
| Open/close all gates | 1 foot/min |

| | |
|---|---|
| PROJECT COST (THROUGH FY 1977) | $1,968,000 |
| DATE OF COMPLETION | July 1958 |
| MAINTAINED BY | New England Division, Corps of Engineers |

PERTINENT DATA
CONANT BROOK DAM

July 1978

| | |
|---|---|
| LOCATION | Conant Brook; Monson, Massachusetts |
| DRAINAGE AREA | 7.8 Square Miles |
| STORAGE USES | Flood Control |

RESERVOIR STORAGE

| | Elevation (ft, msl) | Stage (ft) | Area (acres) | Capacity | |
|---|---|---|---|---|---|
| | | | | Acre-Feet | Inches on Drainage Area |
| Invert | 694 | 0 | 0 | 0 | 0 |
| Spillway Crest | 757 | 63 | 158 | 3,740 | 9.0 |
| Maximum Surcharge | 766 | 72 | 216 | 5,400 | 13.0 |
| Top of Dam | 771 | 77 | - | - | - |

EMBANKMENT FEATURES

| | |
|---|---|
| Type | Earth w/rockfill slope protection |
| Length | 1,050 |
| Top Width (feet) | 20 |
| Top Elevation (ft msl) | 771 |
| Maximum Height (feet) | 85 |
| Volume (cubic yards) | 340,000 |
| Dike | One - 5,600 feet northeast of Dam; 980 feet long by 14 feet high |

SPILLWAY

| | |
|---|---|
| Location | Right abutment |
| Type | Ogee weir, chute spillway |
| Crest Length | 100 feet |
| Crest Elevation | 757 feet msl |
| Surcharge Elevation | 766 feet msl |

SPILLWAY DESIGN FLOOD

| | Original Design |
|---|---|
| Peak Inflow (cfs) | 11,900 |
| Peak Outflow (cfs) | 10,750 |
| Volume Runoff (acre-feet) | 9,650 |

OUTLET WORKS

| | |
|---|---|
| Type | Circular conduit |
| Tunnel Diameter | 36 inches |
| Tunnel Length (feet) | 405 |
| Service Gate, Type | None |
| Downstream Channel Capacity | 225 cfs |
| Discharge at Spillway Crest | 225 cfs |

LAND ACQUISITION

| | |
|---|---|
| Fee Elevation (ft msl) | 762 |
| Fee (acres) | 456 |
| Easement (acres) | 2 |

MAXIMUM POOL OF RECORD

| | |
|---|---|
| Date | Feb. 1970 |
| Stage (feet) | 18 |
| Elevation (ft msl) | 712 |
| Percent Full | 7 |

UNIT RUNOFF

| | |
|---|---|
| One inch runoff | 416 acre feet |

| | |
|---|---|
| PROJECT COST (THROUGH FY 77) | $2,950,000 |
| DATE OF COMPLETION | 1966 |
| MAINTAINED BY | New England Division, Corps of Engineers |

MANUAL OF WATER CONTROL
CHICOPEE RIVER WATERSHED
MASSACHUSETTS

# CHAPTER I

## INTRODUCTION

1. REGULATION MANUAL

a. Authorization. This report is prepared pursuant to authority contained in ER 1110-2-240, dated 22 April 1970, Reservoir Regulation and EM 1110-2-3600, dated 25 May 1959, which requires that manuals of reservoir regulation for flood control, navigation or multipurpose reservoirs be prepared whenever storage allocated to one or more of the functions is the responsibility of the Corps of Engineers. Requirements given in the draft of "A Guide for Preparing Water Control Manuals for Lakes, Reservoirs, Locks and Dams, Hurricane Barriers, Reregulating Structures, Controlled Channels and Floodways, Office, Chief of Engineers," January 1973 were followed in the preparation of this manual.

b. Purpose and Scope. This manual will serve as a guide and reference source for higher authority, reservoir regulation and maintenance personnel in the New England Division Office, respective project managers and other personnel who may become concerned with, or responsible for, regulation of the reservoirs in the Chicopee River watershed. Included in the manual are the following chapters:

(1) Introduction. A brief history of flood problems and studies which led to the authorization of the Chicopee River watershed flood control projects, including statistical data relative to population, industry and agriculture, and a description of the physical features of all Corps projects, Soil Conservation Service projects, and signficant non-Federal projects.

(2) Management. A general description of the functional responsibilities of the Corps in regard to regulation of the projects, with a listing of all interagency coordinating agreements.

(3) Hydrometeorology. A general description of the watershed and major tributaries, including topographic features and a general coverage of the hydrologic and meteorologic data, i.e., temperature, precipitation, snowfall, snow cover, storms, streamflow and floods.

(4) Communications and Data Collection. A brief description of the means of reporting from field to office such as used by the project managers during nonflood and flood periods, and of the river reporting network and Automatic Hydrologic Radio Reporting System.

(5) Hydrologic Forecasts. A description of all forecasts used by Reservoir Control Center personnel in regulating the projects in the basin, including precipitation forecasts from the National Weather Service and river predictions from the River Forecast Center at Bloomfield, Connecticut and the Corps.

(6) Reservoir Regulation. A detailed discussion of the regulation procedures and watershed flood control plan for the two existing flood control dams.

(7) Hydrologic Equipment. A brief resume of hydrologic equipment used and means of maintaining it.

c. Related manuals. Routine operations and maintenance activities at Barre Falls and Conant Brook Dams are performed by the project managers at Barre Falls Dam and Westville Lake, respectively. These managers function under the supervision of the Reservoir Branch of the Operations Division which prepared the Operations and Maintenance Manuals, June 1972, for Barre Falls Dam and Conant Brook Dam. These manuals give essential operation and maintenance instructions to operating personnel for the upkeep, repair, maintenance and operation of project facilities.

2. PROJECT DESCRIPTIONS

a. Location. The Chicopee River watershed (plate G-3) is located in central Massachusetts within the confines of Worcester, Franklin, Hampshire and Hampden Counties.

The Barre Falls Dam (plate G-60) is located in Barre, Massachusetts on the Ware River. The dam is about 32 miles upstream of the confluence of the Ware and Swift Rivers and about 52 miles upstream of the mouth of the Chicopee River.

Conant Brook Dam (plate G-61) is located on Conant Brook in the town of Monson, Massachusetts. This location is about 7 river miles from the Quaboag River, about 12 miles from the confluence of the Quaboag and the Chicopee Rivers and nearly 30 river miles from the mouth of the Chicopee River.

b. Purpose. Both Barre Falls and Conant Brook Dams are operated to reduce flood stages at downstream communities within the watershed. In addition Barre Falls helps to reduce flood stages along the Connecticut River.

c. Physical Components.

(1) Barre Falls Dam. Important project components consist of a rolled earth and rockfill dam, a rock chute-type spillway with concrete ogee weir, 3 dikes located in saddles in the rim of the reservoir, outlet works, storage capacity for flood control.

At spillway crest elevation, 807 feet msl, Barre Falls Reservoir, a dry bed reservoir, has a capacity of 24,000 acre-feet, equivalent to 8.2 inches of runoff from the contributing drainage area of 55 square miles. When filled to spillway crest, the reservoir will have a surface area of about 1400 acres.

The dam embankment, 885 feet in length and maximum height of 60 feet above streambed consists of rock and earthfill and is shown on plate G-7. The top of dam at elevation 830 feet msl provides 18 feet of spillway surcharge and 5 feet of freeboard. A top width of 25 feet accomodates a 16-foot paved access road, and the embankment slopes 1 on 2.0 on the downstream side and 1 on 2.5 on the upstream side of the dam.

There are three dikes, with a maximum height of 48 feet, which total 3,215 feet in length. These dikes constructed of rolled rockfill with an impervious fill upstream blanket, bring elevations up to 830 feet msl in three saddles along the southern rim of the reservoir.

The spillway is located on the right abutment adjacent to the dam. Components of the spillway include the approach channel, discharge channel and a 60 foot long concrete ogee weir with a fixed crest at elevation 807.0 feet msl (46-foot stage). Plan, profile and cross section of the spillway are shown on plate G-8.

The outlet works are in the left abutment and consist of an intake channel and a 9′-8" diameter horseshoe conduit. The conduit is 250 feet long and discharges are controlled by two 4.5 foot wide by 9.0 foot high sluice gates controlled from the control tower. Plan and sections of the outlet works are shown on plate G-7.

(2) Conant Brook Dam. The important physical components include a rolled earth dam and dikes, a chute spillway composed of a concrete ogee weir, outlet works, and storage capacity for flood control. The General Plan for Conant Brook Dam is shown on Plate G-9.

At spillway crest (757 feet msl) Conant Brook Reservoir, a dry bed reservoir, has a flood control storage capacity of 3,740 acre-feet, equivalent to 9.0 inches of runoff from the contributing drainage area of 7.8 square miles. When filled to spillway crest, the reservoir will have a surface area of 158 acres.

The dam embankment, about 1,050 feet in length and maximum height of 85 feet above streambed, consists of rolled earthfill with an impervious core and rock slope protection. The top of dam, elevation 771 feet, provides 9.0 feet of spillway surcharge and 5.0 feet of freeboard. The top width of 20 feet accommodates a 16-foot paved access road and the embankment slopes vary from 1 on 3.0 to 1 on 2.5.

A rolled earthfill dike, located at the north end of the reservoir, is 980 feet in length with a maximum height of 14 feet; the top of the dike is at elevation 771.

The spillway consists of an approach channel, a concrete ogee weir located on the right bank and a discharge channel. The weir has a length of 100 feet with a crest elevation of 757 feet msl. A plan and profile is shown on plate G-10.

The outlet works consist of an inlet channel, a single ungated 36-inch diameter conduit with trash rack to prevent clogging and an outlet channel. The intake channel (plate G-11) is 10 feet wide excavated in rock to elevation 694 feet msl.

<u>THE PROJECT IS UNSTAFFED AND SELF REGULATING.</u>

3. HISTORY OF PROJECTS

a. <u>Authorization</u>. Barre Falls Dam and Reservoir was authorized as a project for the Chicopee River watershed in the Flood Control Act of 18 August 1941 (Public Law No. 228, 78th Congress) and 22 December 1944 (Public Law No. 534, 78th Congress).

Conant Brook Dam and Reservoir was authorized by the Flood Control Act of 1960 (House Document 434, 86th Congress 2nd Session).

b. <u>Construction</u>. Construction on Barre Falls Dam was initiated in 1956 and completed in May 1958. Construction on Conant Brook Dam was initiated in 1964 and completed in September 1966.

c. <u>Corps of Engineers Local Protection Projects</u>. There are five local protection projects in Massachusetts in the Chicopee River watershed. These projects are briefly discussed below and Table G-1 includes pertinent data.

(1) <u>Chicopee</u>. This local protection project, completed in 1958, is located in Chicopee, Massachusetts along the left bank of the Connecticut River and right bank of the Chicopee River. Primarily, it provides protection against flood stages on the Connecticut River, with backwater up the lower Chicopee River. The project consists of 21,700 feet of earth levees and 3,200 feet of concrete flood walls. The system also includes 3 stoplog structures and 5 pumping stations

with appurtenant drainage structures. The project is designed to protect against a flood discharge of 312,000 cfs which is about 15 percent greater than the March 1936 flood of record. Local interests provided the lands, right-of-way, and relocations required for the work and constructed the necessary sewerage facilities. General plans for this project are shown on plate G-12.

(2) Chicopee Falls. This local protection project, completed in 1965, is located on the left bank of the Chicopee River in Chicopee, about 2-1/2 miles above the mouth of the river. At this point, the Chicopee River flows in a circuitous direction - first, from east to west, then south, and then again in a westerly direction. The protection consists of 1,420 feet of concrete floodwalls and about 3,600 feet of earth dikes extending between the Chicopee Dam and high ground owned by the U.S. Rubber Company. Included in this improvement are three stoplog structures, two pumping stations (used to remove storm water runoff and sewage into the Chicopee River during high flows) and some channel alignment. The project is designed for a Chicopee River discharge of 70,000 cfs, which is the standard project flood modified by Barre Falls and Conant Brook Reservoirs. General plans for the local protection project are shown on plate G-13.

(3) Three Rivers. This local protection project is located at the confluence of the Chicopee, Quaboag and Ware Rivers in Palmer, Massachusetts. Consisting of deepening and widening, the channel improvement extends along the Chicopee River for about 2800 feet from the New England Power Company to the confluence of the Chicopee, Quaboag and Ware Rivers. From this confluence, the project continues about 700 feet up the Ware and about 1400 feet up the Quaboag River. The project also includes the removal and/or construction of several appurtenant structures (i.e. bridges, dams, etc.).

Due to the channel restrictions caused by adjacent industrial buildings and bridges, it was only economically feasible to design this project for a flood of 50,000 cfs, equivalent to 72 percent of the SPF. This degree of protection is about 25 percent greater than the maximum flood of record modified by Conant Brook and Barre Falls. Additional information on the project is shown on plates G-14 and G-15.

(4) Ware. This local protection project, completed in 1959, is located in Ware on the Ware River about 21 miles northeast of Springfield and 22 miles west of Worcester, Massachusetts. The project consists of 11,800 feet of channel improvement (straightening, widening and deepening of the Ware River and lower Muddy Brook), thus providing for a greater flow of water through the town. The project also includes the construction of two dikes about 1,100 feet in length and the elimination of accumulated interior runoff by the use of portable pumps owned by the town. Protection is provided for an event

TABLE G-1
PERTINENT DATA
LOCAL PROTECTION PROJECTS
CHICOPEE RIVER WATERSHED

| PROJECT LOCATION | CHICOPEE, MA. | CHICOPEE FALLS, MA. | PALMER, MA. (THREE RIVERS) | WARE, MA. | W. WARREN, MA. |
|---|---|---|---|---|---|
| RIVER | Connecticut and Chicopee Rivers | Chicopee River | Chicopee, Ware, Quaboag Rivers | Ware River and Muddy Brook | Quaboag River |
| CHANNEL IMPROVEMENTS | | | | | |
| Lenght (ft) | -------- | -------- | 5200 | 12,000 | 1750 |
| Bottom Width (ft) | -------- | 200 to 250 | 80 to 200 | 90 | -------- |
| Side Slopes | -------- | -------- | varied | 1 on 2 | -------- |
| DIKES | | | | | |
| Length (ft) | 21,700 | 3620 | -------- | 1,800 | 60 |
| Top Width (ft) | -------- | 15 | -------- | 18 and 4 | 3 |
| Side Slopes | -------- | 1 on 2 & 1 on 2.5 | -------- | 1 on 2 & 1 on 8 | 1 on 1.5 |
| FLOOD WALLS (ft) | 3,200 | 1420 | -------- | -------- | 450 |
| INTERIOR DRAINAGE | 5 pumping stations, modification and addition to existing drains | 2 pumping stations, modification and addition to existing drains | -------- | New flap valve and sluice gate | Modification and addition to existing drains |
| MISC. FEATURES | 3 stoplog structures | 3 stop log structures Channel widening and deepening | Channel widening and deepening | ---------- | Stone slope bank protection and channel improvement |
| PROJECT FLOOD (cfs) | 312,000 | 70,000 | 50,000 | 20,000 - 22,000 | 11,000 |
| FLOOD OF RECORD (cfs) | 272,000 (Mar. 1936) | 42,500 (Sept. 1938) | 35,500 (Aug 1955) | 20,000-22,000(Sept 1938) | 8300 (Aug 1955) |
| FREEBOARD (ft) | 3 to 5 | 3 | -------- | 2 | 2.6 to 2.7 |
| PROJECT COST(Thru FY78) | $1,988,000 | $2,670,000 | $2,280,000 | $485,000 | $454,000 |
| DATE STARTED | 1936 | 1963 | 1964 | 1958 | 1962 |
| DATE COMPLETED | 1941 | 1965 | 1966 | 1959 | 1963 |
| MAINTAINED BY | City of Chicopee | City of Chicopee | Comm. of Mass. | Town of Ware | Town of W. Warren |

equal to the flood of record (September 1938) of 20,000 cfs above Muddy Brook, and 22,000 cfs below the brook. The general plan and vicinity map for this project is shown on plate G-16.

(5) West Warren. This local protection project, completed in 1963, provides protection for the highly industrialized section of West Warren along the west bank of the Quaboag River.

The improvements consist of an earth and rockfill dike, concrete floodwalls, channel improvements, reconstruction of an existing bridge, and the removal of two utility bridges. The project provides protection for a standard project flood of 11,000 cfs which is 30 percent greater than the record flood of August 1955. Channel improvements include deepening, widening and clearing of the existing channel. Also, rock slope protection for the banks is provided at many points along the river.

General plans for the West Warren local protection are shown on plate G-17 and profiles are shown on plate G-18.

d. Soil Conservation Service Projects.

(1) General. The Soil Conservation Service (SCS) of the U.S. Department of Agriculture has constructed flood protection projects throughout New England and in the Connecticut River basin. These projects, authorized by the Watershed Protection and Flood Prevention Act, Public Law 566, are associated with small watersheds up to 250,000 acres in area. Water impoundments under the act are limited to 12,500 acre-feet of flood storage and 25,000 acre-feet total storage.

SCS impoundment structures are regulated by an ungated principal spillway which is essentially an overflow weir, as shown on plate G-19. The spillway, located in the outlet structure, is generally designed so that its outflow combined with flood storage will control all events up to and including the 100-year storm. Storms in excess of this will activate an emergency spillway, which is generally a grassed earth spillway built at one or both ends of the dam and discharging downstream from the toe of the retarding structure.

(2) Quaboag River Watershed. In the Quaboag River watershed, the SCS has constructed or has prepared work plans for nine flood protection works. Pertinent data for these projects are listed in table G-2 and plate G-20 shows their locations.

e. Non-Federal Projects.

(1) Massachusetts Metropolitan District Commission Water Supply.

TABLE G-2

SCS PROJECTS IN THE
QUABOAG RIVER WATERSHED

SCS IMPOUNDMENTS

| Site | River | Drainage Area sq.mi. | Flood Control Storage Acre/Feet | Flood Control Storage Inches | Principal Spillway Max. Discharge Capacity CFS | Principal Spillway Max. Discharge Capacity CSM | Emergency Spillway Design Capacity CFS | Emergency Spillway Design Capacity CSM | Storage Purposes[1] | Construction Status[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| Moose Hill | Shaw Brook | 4.7 | 1530 | 6.1 | 143 | 30 | 7000 | 1490 | S,F,R | - |
| Horsepond | Horsepond Brook | 4.1 | 1396 | 6.4 | 105 | 26 | 3640 | 770 | S,F,R | C |
| Kittredge | Fivemile River | 1.7 | 439 | 4.7 | 100 | 51 | 4200 | 2470 | S,F,R | C |
| Rice | Trout Brook | 3.4 | 1000 | 5.6 | 108 | 32 | 3990 | 1170 | S,F | - |
| Meadow | Sucker Brook | 6.3 | 2358 | 7.0 | 138 | 22 | 13300 | 2110 | S,F,R | - |
| Sucker | Sucker Brook | 1.6 | 603 | 6.9 | 61 | 38 | 3380 | 2110 | S,F | C |
| Lamberton | Lamberton Brook | 4.4 | 803 | 3.4 | 268 | 61 | 7200 | 1640 | S,F | C |
| | Total | 26.2 | 8129 | 5.0 | | | | | | |

SCS CHANNEL IMPROVEMENT

| Site | River | Type of Improvement | Construction Status |
|---|---|---|---|
| E. Brookfield, Mass. | E. Brookfield River | Flood Wall | C |

(1) S - Sediment, F - Flood Water, WS - Water Supply, R - Recreation.
(2) Construction Status : C - Constructed.

(a) General. Large portions of the Swift and Ware River watersheds are controlled by facilities of the Metropolitan District Commission (MDC) of the Commonwealth of Massachusetts as a source of water supply for metropolitan Boston. These facilities consist of the Coldbrook Intake in the Ware River and Quabbin Reservoir in the Swift River watersheds. These projects, discussed in the following paragraphs, control about 283 square miles of drainage area in the two watersheds, and therefore have considerable impact on discharges in the Chicopee River watershed.

(b) Coldbrook Diversion. The Coldbrook Diversion is situated about 4 miles downstream of Barre Falls Dam and controls 96.8 square miles of drainage area of the Ware River. The function of this structure is to normally divert water from the Ware River to Quabbin Reservoir via the Quabbin Aqueduct. Diversion from Coldbrook may also be directed to Wachusett Reservoir in Clinton, Massachusetts, 10 miles northeast of Worcester via this same aqueduct. This is not normally done however, as it is MDC's policy to store water taken from the Ware River in Quabbin Reservoir prior to being released into the MDC water supply.

The normal diversion period is 6 months (1 December to 31 May), but may be extended to 8 months (15 October to 15 June) if approved by the Massachusetts Board of Health. In addition to this restriction, MDC is required by law to allow a minimum discharge of 132 cfs to pass the Coldbrook Intake for use by downstream interests. During diversion, the minimum discharge is obtained by a siphon arrangement which automatically divides the flow into two parts, with the excess over 132 cfs being diverted. Th maximum diversion capacity to Quabbin via the aquaduct is 890 cfs, and combined capacity to both Wachusetts and Quabbin Reservoirs is 2960 cfs. Discharges in both directions are accomplished entirely by gravity.

Discharge measurements for both diversion and riverflow at Coldbrook Intake are obtained by recording flow meters. The elevation of all siphon crests is 650.35 msl (656.0 Boston City Base) with an emergency spillway located on the left bank, 1 foot higher. A schematic of the diversion apparatus is shown on plate G-21.

Headwater elevations may be obtained from a staff gage installed by the Corps on the upstream side of a catwalk that crosses the pool about 20 feet above the dam. The bottom of the staff gage is set at spillway crest elevation (651.35 msl). Stage and discharge values for Coldbrook Intake are generally supplied by MDC personnel who are on duty 8 hours a day, Monday through Friday. During other hours, river stages may be taken from the NED staff gage.

(c) Quabbin Reservoir. The Quabbin Reservoir, shown on plate G-22 impounds water from 186 square miles of the Swift River watershed and, when Coldbrook is diverting, 96.8 square miles of the Ware River. Minimum downstream flow requirements were established by a U.S. Supreme Court decision responding to a suit brought by the State of Connecticut enjoining the Commonwealth of Massachusetts from diverting water from the Connecticut River basin. As a result, during the period 1 June to 30 November, average minimum flow requirements for the Swift River downstream of Windsor Dam will be 110 cfs (71 mgd) when the flow on the Connecticut River at Montague City is 4,650 cfs or less. During this period, when the flow at Montague City is between 4,650 and 4,900 cfs the average minimum flow downstream will be 70 cfs (45 mgd). At all other times, Quabbin Reservoir will pass an average minimum flow of 32 cfs (20 mgd). These minimum discharges are made through outlet works, which include a hydroelectric station at the foot of the dam.

The overflow spillway of Quabbin Reservoir is located beyond a knoll on the eastern end of Windsor Dam. Spillway crest elevation is at 530 feet above Boston City Datum (BCD) or 524.4 feet msl, and total spillway length is 400 feet. Thirty feet of spillway is depressed to 528 feet BCD to allow drawdown of the reservoir in anticipation of spring snowmelt. Stoplogs are then placed along this depressed length once the pool has been lowered. A spillway rating curve with all stoplogs in place is shown on plate G-23 and a photograph of the Quabbin spillway is shown on plate G-24. In the southeastern corner of the reservoir, releases are made from Quabbin to Wachusett Reservoir via the Quabbin aqueduct. This aqueduct, a 13-foot high and 24.6 mile long arch-shaped tunnel excavated in rock, is capable of discharging 925 cfs when Quabbin levels are at spillway crest. Pertinent data on Quabbin Reservoir is shown on table G-3.

f. Modification to Authorization. There have been no modifications to the authorized project plans of Barre Falls or Conant Brook dams.

g. Previous Reports. Public Law 738, 74th Congress, approved 22 June 1936, authorized a 10-reservoir system for the Connecticut River Basin in New Hampshire and Vermont as set forth in House Document 412, 74th Congress, 17 February 1936, " . . . in the interest of flood control, power development and navigation . . ."

Public Law 761, 75th Congress, passed 28 June 1939, approved a comprehensive plan for flood control and other purposes as set forth in House Document 455, 75th Congress. This document increased the reservoirs in the comprehensive plan to twenty, with ten alternatives, and also authorized seven local protection works. The Chicopee Local Protection Project was included in this plan.

TABLE G-3

PERTINENT DATA
QUABBIN RESERVOIR

| | |
|---|---|
| 1. Location | Belchertown, Hardwick, New Salem, Pelham, Petersham, Shutesbury, Ware |
| 2. Owner | Mass. Metropolitan District Commission (MDC) |
| 3. Drainage Area | 186 Square Miles |
| 4. Project Features | |
| a. Winsor Dam | |
| (1) Type | Rock and Earthfill |
| (2) Length | 2340 feet |
| (3) Maximum Height | 170 feet |
| (4) Top Elevation | 544.4 feet msl = 550 feet above Boston City Datum (BCD) |
| (5) Volume | 4 million cubic yards |
| b. Goodnough Dike | |
| (1) Type | Rock and Earthfill |
| (2) Length | 2140 feet |
| (3) Maximum Height | 135 feet |
| (4) Top Elevation | 544.4 feet msl = 550 Ft. (BCD) |
| (5) Volume | 2.5 million cubic yards |
| c. Quabbin Spillway | |
| (1) Top Elevation | 524.4 feet msl = 530 Ft. (BCD) |
| (2) Crest Length | 400 feet |
| d. Storage | |
| (1) Volume | 1,300,000 A.F. (131 inches of R.O.) |
| (2) Reservoir Area | 39.4 Sq. Mi. |
| 4. Date of Completion | 1936 |

Public Law 22, 77th Congress, passed 18 August 1941, authorized construction of the reservoirs of the comprehensive plan approved by the 1938 act, and modified the plan to include the works recommended by the Chief of Engineers in House Document 724, 76th Congress, 3rd Session. Included in these modifications were plans for the construction of Barre Falls Dam on the Ware River and West Brookfield Dam on the Quaboag River.

Public Law 858, 80th Congress, 2nd Session, 30 June 1948 - Section 205 of this Act authorizes the Secretary of the Army to allot money for the construction of small flood control projects not specifically authorized by Congress. A limit of $100,000 was originally set for the expenditure on any one project; however, this figure has been amended and now stands at $2 million. For areas which had been declared disaster areas within the 5 years prior to project authorization by the Chief of Engineers, an amount of $3 million may be allotted. Studies of projects under this authority must be initiated by local interests and assurances of local cooperation and cost-sharing must be made by them before appropriation of Federal funds for construction can be allotted. Projects undertaken under this authority are commonly called "205 Projects". The local protection projects at Ware and West Warren are 205 Projects.

The New England-New York Interagency Committee (NENYIAC), organized at the direction of the President of the United States on 9 October 1950, made a comprehensive survey of the land, water and related resources of the New England-New York area. The Committee, comprised of six Federal agencies: Departments of Army; Agriculture; Commerce; Health, Education and Welfare; Interior and the Federal Power Commission together with a representative from each of the 7-area states, submitted a report dated 27 April 1956. A summary of this report is published in Senate Document 14, 85th Congress, 1st Session, 17 January 1957.

The Corps of Engineers report: "New England Basins, Report on Flood Control and Allied Purposes," dated 30 June 1955, presented a comprehensive flood control plan for the Connecticut River basin essentially the same as that of the NENYIAC Report.

Public Law 86-645, 86th Congress, 14 July 1960 authorized several projects in the Connecticut River basin as set forth in House Document 434, 86th Congress, 2nd Session, 24 June 1960. Included in this plan was flood protection in the Chicopee River basin which included Conant Brook Dam and Reservoir, and Chicopee Falls and Three Rivers local protection projects.

The Comprehensive Water and Related Land Resources Investigation, Connecticut River basin, completed in June 1970, recommended a basin wide flood control plan which included structural measures to be prepared by the Corps of Engineers and the Soil Conservation Service. An operational change recommended for Barre Falls included in Appendix M of this report, is discussed below.

Due to severe water quality of the watershed, it was recommended that regulation at Barre Falls Dam be altered to include the retention of a 5,460 acre-foot (1.9 inches) pool for flow augmentation releases. This concept is predicated on secondary treatment facilities first being constructed at the known point sources of pollution. However the state and local agencies have not taken an active interest in this proposal and the study in currently inactive.

h. Flood Plain Information Reports.

(1) General. These reports analyze topographic features and hydrologic history to determine flood potential (i.e., flood plain delineations and frequency of flood stages and discharges). This information, where determined, is available to planning groups, zoning boards, private citizens, real estate or industrial developers and others to determine the wise use of flood plain.

(2) Chicopee River Watershed. Flood Plain Information Reports authorized under Section 206 of the Flood Control Act of 1960 (Public Law 86-645) have been prepared for several communities in the Chicopee River watershed. These communities are tabulated below:

| Community | River | Completed |
|---|---|---|
| Palmer | Quaboag, Swift and Ware | Sept. 1977 |
| Chicopee, Springfield, Ludlow, Wilbraham and Palmer | Chicopee | Sept. 1973 |
| Monson | Chicopee, Conant Brook | Dec. 1963 |

i. Flood Insurance Studies. These studies, carried out under provision of the National Flood Insurance Act of 1968 (Public Law 90-448 Title XIII), map communities eligible for the Flood Insurance Program by risk zones and determine insurance rates. Administration of the program is handled by the Department of Housing and Urban Development (HUD), which utilizes services of the private insurance industry with Federal subsidization to provide flood insurance to family dwellings and small business properties and their contents.

As of November 1978, the only community in the watershed which has had a final insurance study prepared and has accepted HUD guidelines for flood plain zoning is the city of Chicopee.

j. Principal Project Problems. There have been no major project problems with the structure or the reservoir area at either Barre Falls or Conant Brook Dams.

4. ECONOMY OF THE WATERSHED

a. General. The economy of the Chicopee River watershed, encompassing all or part of 37 towns and 2 cities, is built around manufacturing. The leading industries which employ close to 60 percent of all manufacturing workers are electronics, fabricated metals, machinery and clothing. A major portion of the industrial activity is concentrated in the south and central sections of the basin and is well distributed in every town and village along the banks of the Chicopee, Ware and Quaboag Rivers.

Agriculture in the Chicopee River watershed is limited to less than 20 percent of the total land area. This is mainly because (1) approximately 16 percent of the drainage area in the vicinity of Quabbin Reservoir (117 squre miles), is owned and utilized by the Commonwealth of Massachusetts for water supply purposes and (2) a large part of the basin is hilly, and the soil rough and stoney. The only noticeable exception is the upper Quaboag River watershed where some poultry raising, dairy farming and apple growing takes place.

Other activities in the watershed include granite quarrying and sand and gravel excavation. In addition, recent forestation and forest management activities are expected to increase potential lumber resources in the basin.

b. Population. Population of the Chicopee River watershed is distributed unevenly throughout the basin, with the largest portion settling in the more urban areas of the lower watershed. Population trends for several cities and towns in the watershed are shown below:

| Town or City | 1950 | 1960 | 1970 |
|---|---|---|---|
| Springfield | 162,400 | 174,500 | 163,900 |
| Chicopee | 49,200 | 61,500 | 66,700 |
| Barre | 3,400 | 3,500 | 3,800 |
| Ware | 7,500 | 7,500 | 8,200 |
| Palmer | 9,500 | 10,400 | 11,700 |
| Monson | 6,100 | 6,700 | 7,400 |
| North Brookfield | 3,400 | 3,600 | 4,000 |

c. <u>Family Income</u>. The median income for families in Massachusetts for 1970 was $10,835. Towns and cities in the Chicopee watershed were lower than that for the State, with Springfield only $9,612 and Chicopee, the second largest city $9,738.

# CHAPTER II

## MANAGEMENT

5. GENERAL

a. Project Owner. Both Barre Falls and Conant Brook Dams are owned by the Department of the Army, Corps of Engineers.

b. Operating Agency. The New England Division is responsible for the operation of both projects. Staffing at Barre Falls is on a normal work week, Monday through Friday, 0800 to 1630 hours, and from 0800 to 0900 on Saturday and Sunday, with the project manager at Barre Falls living at the site. During flood emergency conditions, Barre Falls will be staffed on a 24-hour basis or as instructed by RCC for the duration of the emergency.

Conant Brook is the responsibility of the Westville Lake Project Manager. It is his responsibility, through periodic visits to Conant Brook, to check on conditions which might affect regulations at the project.

c. Regulating Agency. The New England Division, Corps of Engineers is responsible for the regulation of both projects.

6. FUNCTIONAL RESPONSIBILITIES

a. Corps of Engineers. Reservoir regulation activities of the New England Division are performed by the Reservoir Control Center (RCC), a section of the Water Control Branch. Administrative and maintenance activities at Barre Falls and Conant Brook are performed by the project managers at Barre Falls and Westville, respectively. Supervision of the project managers is the responsibility of the Reservoir Branch of the Operations Division. This responsibility is facilitated by each project's respective basin manager. However, during regulation periods, the managers are responsible to the Reservoir Control Center, and report directly to the Center for information and instructions.

The Water Control Branch of the Engineering Division is comprised of three sections; namely, Reservoir Control, Hydrologic Engineering and Hydraulics and Water Quality. The RCC consists of a staff of highly trained hydrologic engineers who devote full time to regulation activities of reservoirs in New England. Members of the other sections assist RCC personnel during routine and flood operations, and also provide technical assistance as needed. An organization chart for reservoir regulation in the New England Division is shown on plate G-25.

The RCC is divided into basin units, each responsible for receiving routine hydrologic and meteorologic reports and directing reservoir regulation within an assigned river basin. Each unit consists of regulator in charge of the overall operation in the basin, and project regulators who receive reports during working hours or from their homes during nonworking hours. Whenever severe emergency conditions exist, the RCC staffs NED headquarters to assure 24-hour operations as long as necessary.

b. Other Agencies. There are no other Federal, State, county or private agencies that have any responsibility in regulating the flood control aspects of either Barre Falls Dam or Conant Brook Dam.

7. INTER-AGENCY COORDINATION

a. Inter-Agency Agreements. The Corps of Engineers has cooperative working programs with the U.S. Geological Survey, the National Weather Service and its River Forecast Center at Bloomfield, Connecticut. The Corps uses the hydrologic and forecasting information from these agencies in regulating flood control reservoirs in a manner to provide efficient protection for downstream communities.

b. Compacts. Congress, by the passage of Public Law 52, 83rd Congress, 6 June 1953, granted its consent and approval to an interstate compact, covering the Connecticut River Valley, that had been previously ratified by the States of New Hampshire, Vermont, Massachusetts and Connecticut. The principal purposes of the compact are:

(1) Assuring adequate storage capacity for impounding waters in the interest of flood control. Five dams - Union Village, Surry Mountain, Knightville, Tully and Birch Hill were in operation at the time the compact was instituted. These dams were endorsed by the compact and included in the tax sharing clause. Twelve additional locations were agreed upon for future tax reimbursement if constructed.

(2) A system of tax loss reimbursement was set up so that the southern states would share the tax loss with the northern states from Federal acquisition of lands for any flood control dam and reservoir built in the Connecticut River Valley. A tabulation of this tax reimbursement is indicated as follows.

| Recipient State | Percent Tax Loss Reimbursed | Reimbursing State |
|---|---|---|
| Vermont | 40 | Connecticut |
| Vermont | 50 | Massachusetts |
| New Hampshire | 40 | Connecticut |
| New Hampshire | 50 | Massachusetts |
| Massachusetts | 40 | Connecticut |

(3) Providing a joint or common agency through which the signatory states may effectively cooperate in accomplishing the objectives of flood control and water resources utilization in the basin.

The compact also provides for creation of a commission consisting of three representatives from each of the four states with authority to enter into contracts and agreements and to make such ongoing studies and investigations as may be required in the interest of flood control and in cooperation with Federal agencies.

c. News Releases. It is the policy of the Corps of Engineers to cooperate with the local press and all other forms of news media. This cooperation provides the local communities with information regarding regulation of the Chicopee River projects. The primary source of information regarding the regulation of the projects is the Public Affairs Officer who is responsible for issuing all communities to the press and news media.

Whenever project managers receive requests for information from local news media and private citizens, the manager can give out information pertinent to his project, however, he will not make any flood forecasts. Referrals should be made to RCC for additional information.

# CHAPTER III

## HYDROMETEOROLOGY

### 8. DESCRIPTION OF WATERSHED

The Chicopee River watershed, shown on plate G-3, is located in central Massachusetts within the confines of Worcester, Franklin, Hampshire and Hampden Counties. It has a drainage area of 721 square miles and is the largest watershed in the Connecticut River basin. The watershed is generally fan-shaped with a maximum length of about 45 miles and an average width of 16 miles. Relief of the basin varies from elevation 40 feet msl at the mouth of the Chicopee River to elevation 1,720 feet msl at the headwaters of the basin near Princeton, Massachusetts.

The general topography is low, with rolling hills and several upland plains. Many natural lakes and ponds and artificial ponds developed by local power and manufacturing plants are scattered throughout the watershed. The largest of the natural ponds is Quaboag Pond with an area of about 512 acres, while Quabbin Reservoir, the largest man-made lake in the State, has a surface area of 39.4 square miles. The natural and artificial lakes and ponds have a major effect on floodflows in the Chicopee River basin. A schematic profile of the Chicopee River and its tributaries is shown on plate G-26.

The Chicopee River is formed by the Ware and Quaboag Rivers in the community of Three Rivers; the Swift River enters the Ware just upstream of Three Rivers. From Three Rivers, the Chicopee River flows in a general westerly direction to its confluence with the Connecticut River. The Chicopee River from Three Rivers to the Connecticut, includes an additional area of 76 square miles and falls about 260 feet in 18 miles. Major tributaries of the Chicopee are the Ware, Swift and Quaboag Rivers.

The Ware River is formed by the confluence of its East and West Branches in the town of Barre, Massachusetts, and flows in a general southwesterly direction for about 34 miles to its junction with the Quaboag River. The river falls about 450 feet in this distance. Total drainage area at its mouth, including 216 square miles from the Swift River watershed, is 435 square miles. Hills are prominent in the basin and valleys formed by the Ware River are generally steep and narrow and conducive to rapid runoff. However, flows from the upper 55 square miles are controlled by Barre Falls Dam and Reservoir, and additional control of the Ware River is affected by the Metropolitan District Commission Dam and Intake Works at Coldbrook four miles below Barre Falls Dam. The function of the Intake Works is to divert water from the Ware River to Quabbin Reservoir for water supply purposes. The principal tributary of the Ware River is the Swift River.

The Swift River originates at the confluence of its Middle, East and West Branches in Quabbin Reservoir, a major component of the water supply system for metropolitan Boston. Runoff from 186 square miles flows into the reservoir above Winsor Dam (which is maintained and operated by the Metropolitan District Commission), then diverted to Wachusett Reservoir north of Boston. The 39.4 square mile reservoir area comprises 22 percent of the total watershed, and provides a high degree of protection to the Swift River below the dam. Even in the event of a full reservoir at the beginning of a flood, the large amount of surcharge storage significantly reduces the contribution to downstream flood peaks. The Swift River falls about 80 feet in the 9-mile reach between Winsor Dam and its confluence with the Ware River, which is located about 1 mile upstream of the community of Three Rivers.

The Quaboag River watershed has a drainage area of 210 square miles and a 26 mile length from Quaboag Pond to Three Rivers. In the upper part of the basin, the Quaboag River flows through a large swampy river channel. Valley storage in this area of ponds and flat marsh land is very great, and during flood periods large volumes of water are temporarily stored in this natural basin. The stored floodwaters subside gradually at relatively low rates so that the natural topography produces a flood reduction effect somewhat similar to that of an ungated dam and reservoir. The middle reach of the Quaboag River has a relatively steep slope, but the lower river, downstream of the mouth of the Chicopee Brook, is flat. The river fall from West Brookfield to Three Rivers is about 300 feet. The table on page i in the front of the manual lists the principal tributaries of the Chicopee River.

9. CLIMATE AND RUNOFF

a. Precipitation. The mean annual precipitation over the watershed is about 44 inches and is distributed uniformly throughout the year. Average monthly precipitation at Ware, Massachusetts varies from a minimum of 3.4 inches in February to a maximum of 4.6 inches in August. Extremes in monthly precipitation at Ware vary from a minimum of 0.62 inch in February 1957 to a maximum of 20.88 in August 1955. Monthly precipitation records for four stations in or near the watershed are listed in table G-4. Annual precipitation for the same stations are shown on plate G-27.

b. Temperature. The average annual temperatures vary from 45° Fahrenheit in the hilly regions to 50° in the valleys. Recorded temperature extremes at representative stations within or adjacent to the watershed have varied from a maximum of 104° to a minimum of -22°. Table G-5 lists the mean, monthly and the absolute maximum and minimum temperatures at three stations in or adjacent to the watershed.

TABLE G-4

MONTHLY PRECIPITATION
CHICOPEE RIVER WATERSHED
(Depth in Inches)

| Month | Barre Falls Dam, Mass. Elevation - 910 Feet msl (1959 - 1976) Mean | Maximum | Minimum | Ware, Mass. Elevation - 410 Feet msl (1928 - 1976) Mean | Maximum | Minimum |
|---|---|---|---|---|---|---|
| January | 2.69 | 5.75 | 1.00 | 3.31 | 6.67 | 1.01 |
| February | 2.62 | 4.55 | 0.88 | 3.04 | 5.21 | 0.62 |
| March | 2.92 | 5.06 | 1.08 | 3.82 | 7.55 | 1.49 |
| April | 3.25 | 5.07 | 1.07 | 3.88 | 6.79 | 0.71 |
| May | 3.46 | 7.10 | 0.98 | 3.47 | 6.58 | 0.74 |
| June | 3.49 | 6.75 | 1.50 | 3.55 | 9.04 | 1.32 |
| July | 3.59 | 7.25 | 0.61 | 3.84 | 7.94 | 0.76 |
| August | 3.09 | 6.95 | 0.60 | 4.60 | 20.88 | 0.71 |
| September | 3.66 | 9.90 | 1.34 | 3.61 | 14.13 | 0.96 |
| October | 3.02 | 6.38 | 0.63 | 3.69 | 8.85 | 0.71 |
| November | 3.77 | 6.42 | 0.85 | 4.08 | 6.61 | 0.85 |
| December | 3.78 | 8.90 | 1.96 | 3.94 | 7.93 | 0.83 |
| Annual | 39.38 | 53.64 | 26.24 | 44.70 | 60.02 | 26.45 |

| Month | E. Brimfield Lake, Mass. Elevation - 680 Feet msl (1961 - 1976) Mean | Maximum | Minimum | Hardwick, Mass. Elevation - 990 Feet msl (1885 - 1895, 1919 - 1976) Mean | Maximum | Minimum |
|---|---|---|---|---|---|---|
| January | 3.18 | 5.46 | 1.20 | 3.40 | 7.31 | 0.74 |
| February | 3.35 | 5.67 | 1.01 | 3.04 | 7.50 | 0.85 |
| March | 3.71 | 7.52 | 1.85 | 3.61 | 9.64 | 0.98 |
| April | 3.21 | 5.52 | 0.86 | 3.58 | 7.69 | 0.69 |
| May | 3.72 | 6.42 | 1.31 | 3.63 | 7.02 | 1.12 |
| June | 3.68 | 8.03 | 1.02 | 4.15 | 12.38 | 0.72 |
| July | 3.33 | 5.39 | 0.91 | 4.33 | 9.63 | 0.90 |
| August | 3.15 | 6.46 | 1.55 | 4.28 | 17.94 | 0.63 |
| September | 4.24 | 9.99 | 1.61 | 4.09 | 14.54 | 1.17 |
| October | 3.12 | 5.61 | 0.92 | 3.36 | 8.27 | 0.12 |
| November | 4.13 | 6.16 | 0.69 | 4.01 | 7.27 | 0.97 |
| December | 4.78 | 9.93 | 2.52 | 3.59 | 8.34 | 0.67 |
| Annual | 43.64 | 61.05 | 31.70 | 44.92 | 60.67 | 30.50 |

TABLE G-5

MONTHLY TEMPERATURE
CHICOPEE RIVER WATERSHED
(Degrees Fahrenheit)

| | SPRINGFIELD, MASS. 73 Years of Record Through 1976 | | | BARRE FALLS DAM, HUBBARDSTON, MASS. 17 Years of Record Through 1976 | | | WESTOVER FIELD, MASS.(1) 22 Years of Record Through 1964 | | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Mean | Absolute Maximum Recorded | Absolute Minimum Recorded | Mean | Absolute Maximum Recorded | Absolute Minimum Recorded | Mean | Absolute Maximum Recorded | Absolute Minimum Recorded |
| January | 26.8 | 68 | -18 | 20.6 | 60 | -22 | 25.1 | 65 | -21 |
| February | 27.9 | 74 | -18 | 21.9 | 63 | -22 | 27.1 | 65 | -18 |
| March | 36.7 | 87 | -11 | 29.7 | 73 | -6 | 36.0 | 86 | -13 |
| April | 48.5 | 93 | 10 | 42.9 | 89 | 6 | 47.4 | 87 | 13 |
| May | 59.5 | 97 | 27 | 53.5 | 92 | 23 | 57.9 | 93 | 29 |
| June | 68.4 | 101 | 32 | 62.8 | 90 | 29 | 67.2 | 102 | 37 |
| July | 73.3 | 104 | 30 | 67.1 | 93 | 38 | 72.1 | 97 | 45 |
| August | 71.5 | 102 | 39 | 65.1 | 95 | 28 | 69.9 | 100 | 36 |
| September | 63.7 | 102 | 26 | 57.8 | 90 | 24 | 62.2 | 101 | 27 |
| October | 53.4 | 90 | 20 | 47.7 | 84 | 13 | 52.5 | 89 | 17 |
| November | 42.1 | 83 | 4 | 37.4 | 72 | 6 | 41.1 | 81 | 8 |
| December | 30.4 | 66 | -16 | 25.3 | 65 | -14 | 27.8 | 64 | -15 |
| ANNUAL | 50.2 | 104 | -18 | 44.4 | 90 | -22 | 48.9 | 102 | -21 |

(1) Station Discontinued in February 1964

c. Snow and Snow Cover. The average monthly snowfall at Barre Falls Dam, East Brimfield Lake and Springfield are shown in table G-6. Barre Falls and East Brimfield can be considered representative of the headwater region of the watershed, and Springfield is indicative of the lower portion of the watershed.

Snow surveys have been taken by the Corps of Engineers in the upper Chicopee River watershed since 1958. These surveys determine the water equivalence and density of snow cover and hence the runoff potential of the watershed due to snowmelt. The project managers relay this data to RCC, where it is analyzed with similar information from other basins. A weekly snow bulletin is also prepared for Corps use from the end of January through the end of the snowmelt period.

d. Storms. The watershed has experienced storms of four general types, namely:

(1) Extratropical continental storms which move across the basin under the influence of the "prevailing westerlies".

(2) Extratropical maritime storms which originate and move northward along the eastern coast of the United States.

(3) Storms of tropical origin, some which attain hurricane magnitude.

(4) Thunderstorms produced by local convective action or by more general frontal activity.

The most severe storms have been of tropical origin which occur during the late summer and early autumn. The four most serious storms in the watershed in recent years occurred in November 1927, March 1936, September 1938 and August 1955. The events of November 1927, September 1938 and August 1955 were of tropical origin.

e. Runoff

(1) Discharge Records. There are nine USGS gaging stations in the watershed (locations are shown on plate G-3). The period of record for these stations is listed on page i at the front of the manual. A daily hydrograph for the Chicopee River at Indian Orchard from 1936 to 1961 is shown on plate G-29.

(2) Streamflow Data. Average annual runoff for the 49 year period of record for the gage at Indian Orchard is 17.9 inches, with a maximum of 38.9 inches in water year 1938, and a minimum of 7.5 in water year 1966. The mean annual runoff represents about 40 percent of the mean annual precipitation with about 50 percent of this runoff occurring during February through May. The peak discharge for the

TABLE G-6

MONTHLY SNOWFALL
CHICOPEE RIVER WATERSHED
(Depth in Inches)

| Month | Barre Falls Dam, Hubbardston, Massachusetts, 18 Years of Record through 1977 | | East Brimfield Lake, Sturbridge, Massachusetts, 15 Years of Record through 1977 | | Springfield, Massachusetts, 82 Years of Record through 1977 | |
|---|---|---|---|---|---|---|
| | Mean | Percent of Annual | Mean | Percent of Annual | Mean | Percent of Annual |
| January | 14.6 | 24.3 | 15.0 | 23.3 | 12.7 | 26.1 |
| February | 16.6 | 27.7 | 17.0 | 26.4 | 13.8 | 28.4 |
| March | 10.8 | 18.0 | 12.1 | 18.8 | 9.4 | 19.3 |
| April | 2.4 | 4.0 | 2.9 | 4.5 | 1.7 | 3.5 |
| May | T | 0.0 | 0.1 | 0.1 | T | 0.0 |
| June | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| July | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| August | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| September | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| October | 0.2 | 0.3 | 0.3 | 0.5 | 0.0 | 0.0 |
| November | 1.4 | 2.3 | 3.5 | 5.4 | 2.3 | 4.7 |
| December | 14.0 | 23.4 | 13.5 | 21.0 | 8.7 | 17.9 |
| ANNUAL | 60.0 | 100.0 | 64.3 | 100.0 | 48.6 | 100.0 |

TABLE G-7

CORPS OF ENGINEERS
SNOW SURVEY COURSES
CHICOPEE RIVER BASIN, MASSACHUSETTS

| Station | River | Elevation (msl) | Location (Lat.) | Location (Long.) | Period of Record |
|---|---|---|---|---|---|
| Barre Falls | Ware | 820 | 42-26 | 72-02 | Jan. 1958 - Present |
| Hubbardston | Ware | 1020 | 42-29 | 72-01 | Jan. 1958 - Present |
| Princeton | Ware | 1400 | 42-29 | 71-53 | Jan. 1961 - Present |
| Petersham | Swift | 990 | 42-29 | 72-11 | Jan. 1961 - Present |
| Rutland | Ware | 1040 | 42-24 | 71-58 | Jan. 1958 - Present |
| West Brookfield | Quaboag | 650 | 42-13 | 72-07 | Jan. 1958 - Present |
| Wales | Quaboag | 1000 | 42-04 | 72-14 | Jan. 1961 - Present |
| Leicester | Quaboag | 1050 | 42-17 | 71-55 | Jan. 1958 - Present |
| Spencer | Quaboag | 1050 | 42-12 | 71-59 | Jan. 1961 - Present |

TABLE G-8

MONTHLY RUNOFF

CHICOPEE RIVER WATERSHED

| | Ware River near Barre, Mass. (D.A. = 55 sq. mi.) 1946-1977 | | | | | | Ware River at Gibbs Crossing (D.A. = 199 sq. mi.) 1912-1977 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average | | Maximum | | Minimum | | Average | | Maximum | | Minimum | |
| Month | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches |
| January | 95 | 2.0 | 204 | 4.1 | 16 | 0.3 | 302 | 1.8 | 728 | 4.3 | 62 | 0.4 |
| February | 103 | 2.0 | 271 | 5.2 | 31 | 0.6 | 300 | 1.6 | 802 | 4.3 | 89 | 0.5 |
| March | 172 | 3.6 | 338 | 7.1 | 69 | 1.4 | 553 | 3.2 | 1838 | 10.7 | 211 | 1.2 |
| April | 233 | 4.7 | 427 | 9.0 | 82 | 1.6 | 617 | 3.5 | 1394 | 7.9 | 231 | 1.3 |
| May | 123 | 2.6 | 216 | 4.5 | 42 | 0.9 | 379 | 2.2 | 731 | 4.3 | 156 | 0.9 |
| June | 64 | 1.3 | 175 | 3.6 | 14 | 0.3 | 238 | 1.3 | 603 | 3.4 | 65 | 0.4 |
| July | 31 | 0.6 | 91 | 1.9 | 5 | 0.1 | 156 | 0.9 | 714 | 4.1 | 37 | 0.2 |
| August | 24 | 0.5 | 169 | 3.5 | 2 | 0.1 | 120 | 0.7 | 890 | 5.2 | 26 | 0.2 |
| September | 26 | 0.5 | 275 | 5.6 | 2 | 0.1 | 136 | 0.8 | 1707 | 9.9 | 15 | 0.1 |
| October | 43 | 0.9 | 233 | 4.9 | 4 | 0.1 | 142 | 0.8 | 750 | 4.4 | 29 | 0.2 |
| November | 74 | 1.5 | 230 | 4.8 | 7 | 0.2 | 235 | 1.3 | 922 | 5.2 | 34 | 0.2 |
| December | 97 | 2.0 | 204 | 4.3 | 13 | 0.3 | 285 | 1.6 | 736 | 4.2 | 61 | 0.3 |
| Water Year | 91 | 22.5 | 133 | 32.8 | 30 | 7.4 | 288 | 19.8 | 581 | 40.0 | 107 | 7.4 |

| | Quaboag River at West Brimfield (D.A. = 151 sq. mi.) 1913-1977 | | | | | | Chicopee River at Indian Orchard (D.A. = 688 sq. mi.) 1928-1977 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average | | Maximum | | Minimum | | Average | | Maximum | | Minimum | |
| Month | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches |
| January | 255 | 2.0 | 587 | 4.5 | 49 | 0.4 | 921 | 1.6 | 2447 | 4.1 | 221 | 0.4 |
| February | 268 | 1.9 | 748 | 5.3 | 65 | 0.4 | 970 | 1.5 | 2374 | 3.7 | 332 | 0.5 |
| March | 491 | 3.8 | 1399 | 10.8 | 207 | 1.6 | 1615 | 2.7 | 5993 | 10.1 | 686 | 1.2 |
| April | 548 | 4.1 | 1352 | 10.1 | 173 | 1.3 | 1851 | 3.0 | 4117 | 6.7 | 636 | 1.0 |
| May | 315 | 2.4 | 573 | 4.4 | 108 | 0.8 | 1183 | 2.0 | 2680 | 4.5 | 471 | 0.8 |
| June | 179 | 1.3 | 655 | 4.9 | 47 | 0.4 | 776 | 1.3 | 2475 | 4.0 | 229 | 0.4 |
| July | 107 | 0.8 | 524 | 4.0 | 18 | 0.1 | 490 | 0.8 | 2458 | 4.1 | 159 | 0.3 |
| August | 105 | 0.8 | 1440 | 11.1 | 13 | 0.1 | 436 | 0.7 | 3719 | 6.3 | 176 | 0.3 |
| September | 111 | 0.8 | 1369 | 10.2 | 12 | 0.1 | 513 | 0.8 | 5474 | 9.0 | 160 | 0.3 |
| October | 115 | 0.9 | 607 | 4.8 | 12 | 0.1 | 487 | 0.8 | 1953 | 3.3 | 131 | 0.2 |
| November | 172 | 1.3 | 693 | 5.2 | 27 | 0.2 | 702 | 1.1 | 3022 | 4.9 | 154 | 0.2 |
| December | 234 | 1.8 | 600 | 4.6 | 49 | 0.4 | 841 | 1.4 | 2278 | 3.8 | 241 | 0.4 |
| Water Year | 241 | 21.9 | 430 | 39.0 | 104 | 9.4 | 901 | 17.9 | 1952 | 38.9 | 376 | 7.5 |

period of record reached 42,500 cfs on 21 September 1938. The minimum average daily flow was 16 cfs on several occasions during the period 1929 to 1931. The average annual flow for the period of record at Indian Orchard is 901 cfs.

A summary of the maximum, minimum and average monthly and the average annual runoff for selected USGS gaging stations are shown in table G-8. Annual runoff for each station is listed on plate G-30. A summary of runoff data is also shown on pertinent data sheet i. Rating tables for the USGS gages at Indian Orchard, and Barre and several points along the Connecticut River are shown on plates G-31 through G-35.

f. Frequency Analysis

(1) Peak Discharge Frequency. The natural frequency of occurence of discharges was determined for selected U.S. Geological Survey gaging stations and is shown in table G-9. Frequency analyses were made in accordance with procedures in ER 1110-2-1450, "Hydrologic Frequency Estimates", dated 10 October 1962. Following a regional frequency analysis, a skew coefficient of 1.0 was adopted for all tributaries of the Connecticut River. The discharge frequency data shown in table G-9 was prepared for the Comprehensive Water and Related Land Resources: Connecticut River Basin in June 1970, and is based on discharge data which was collected through 1963.

TABLE G-9

NATURAL PEAK DISCHARGE FREQUENCY DATA
CHICOPEE RIVER WATERSHED

| Expected Probability Percent Chance | Recurrence Interval Years | Chicopee R. at Indian Orchard (cfs) | Ware R. at Gibbs Crossing (cfs) | Quaboag R. at West Brimfield (cfs) |
|---|---|---|---|---|
| 0.5 | 200 | 48,000 | 19,300 | 8,100 |
| 1.0 | 100 | 35,500 | 14,500 | 6,300 |
| 2.0 | 50 | 26,000 | 10,800 | 4,900 |
| 5.0 | 20 | 17,000 | 7,100 | 3,400 |
| 10.0 | 10 | 12,000 | 5,200 | 2,600 |
| 20.0 | 5 | 8,450 | 3,700 | 1,900 |
| 50.0 | 2 | 5,100 | 2,450 | 1,270 |
| 99.0 | 1 | 3,400 | 2,020 | 1,030 |

(2) Frequency of Reservoir Fillings. The pool stage at Barre Falls Dam has equalled or exceeded 781 feet msl, which is a about 7 percent of total flood control storage capacity, 19 times from the beginning of operations in July 1958 through June 1978.

TABLE G-10

SIGNIFICANT RESERVOIR STORAGES

BARRE FALLS DAM
1958-1978

| Date | Maximum Elevation | Storage Utilized Inches | Acre-Feet | Percent |
|---|---|---|---|---|
| 1959 Apr | 783.9 | 1.0 | 2,810 | 12 |
| 1959 Jul | 783.0 | 0.9 | 2,450 | 11 |
| 1959 Oct | 783.4 | 0.9 | 2,600 | 11 |
| 1960 Apr | 797.9 | 4.5 | 13,000 | 55 |
| 1962 Apr | 789.0 | 1.9 | 5,500 | 23 |
| 1963 Apr | 783.2 | 0.9 | 2,500 | 11 |
| 1966 Feb | 781.5 | 0.7 | 1,900 | 8 |
| 1966 Mar | 784.4 | 1.1 | 3,025 | 13 |
| 1967 Apr | 782.2 | 0.7 | 2,125 | 9 |
| 1968 Mar | 788.8 | 1.9 | 5,400 | 22 |
| 1970 Apr | 784.4 | 1.1 | 3,025 | 13 |
| 1972 Mar | 781.0 | 0.6 | 1,700 | 7 |
| 1973 Jan | 781.6 | 0.7 | 1,910 | 8 |
| 1973 Feb | 782.1 | 0.7 | 2,100 | 9 |
| 1973 Dec | 784.7 | 1.1 | 3,150 | 14 |
| 1975 Sep | 784.9 | 1.1 | 3,200 | 14 |
| 1976 Jan | 785.3 | 1.2 | 3,420 | 15 |
| 1977 Mar | 786.1 | 1.3 | 3,950 | 16 |
| 1978 Jan | 784.2 | 1.0 | 2,940 | 12 |

CONANT BROOK DAM
1966-1978

| Date | Maximum Stage | Storage Utilized Inches | Acre-Feet | Percent |
|---|---|---|---|---|
| 1968 Mar | 17.6 | 0.5 | 225 | 7 |
| 1970 Feb | 18.0 | 0.6 | | 7 |
| 1970 Apr | 15.0 | 0.4 | 150 | 4 |
| 1973 Feb | 16.6 | 0.5 | 195 | 6 |
| 1973 Dec | 16.7 | 0.5 | 195 | 6 |
| 1975 Sep | 17.2 | 0.5 | 200 | 6 |
| 1976 Jan | 17.8 | 0.5 | 235 | 7 |
| 1978 Jan | 16.5 | 0.5 | 190 | 6 |

The pool stage at Conant Brook has equalled or exceeded 15 feet, which is about 4 percent of total flood control storage capacity, 8 times from the beginning of operations in September 1966 through June 1978.

A tabulation of these operations, with the amount of floodwaters stored, is given in table G-10. The area-capacity table and area-capacity and percent full curves are shown on plate G-36 to G-38 for Barre Falls Dam and on plates G-39 to G-41 for Conant Brook Dam.

## 10. CHANNEL AND FLOODWAY

During the non-growing season, the channel capacity downstream of Barre Falls Dam on the Ware River is approximately 1000 cfs. During the growing season, approximately late April to October, this value drops to about 600 cfs.

Principal damage centers in the watershed during past floods have been at Ware and Hardwick along the Ware River and Chicopee and Palmer along the Chicopee River area. Important index stations in the watershed are the staff gage on the Route 32 highway bridge in Barre Plains (drainage area = 115 square miles), the USGS gage at the Coldbrook diversion (drainage area = 96.8 square miles) and the USGS gaging station at Indian Orchard (drainage area = 688 square miles). On the Connecticut River, the National Weather Service gage at Springfield is monitored by RCC for the regulation of projects to maintain stages on the mainstem.

In general Barre Falls is regulated to try and keep stages below 5.5 feet during the non-growing season and below 2.5 feet during the growing season. The Coldbrook Diversion is capable of diverting 890 cfs to Quabbin Reservoir and diverting 2960 cfs to both Quabbin and Wachusett Reservoir simultaneously. However this is rarely done. Ware River water is often highly colored particularly during periods of high flow, and is normally diverted only to Quabbin Reservoir which acts as a large settling basin. Therefore, it is evident that the magnitude of releases will be governed by conditions downstream of Coldbrook during nondiversion periods. Releases from Barre Falls bringing downstream flows up to maximum channel capacity should be made during Phase III regulation, provided these releases do not exceed inflow into the reservoir.

Releases from Conant Brook Reservoir are automatically limited by the size of the outlet conduit. Maximum discharges through the outlet will not exceed 225 cfs, which is considered to be the downstream channel capacity.

11. FLOODS OF RECORD

a. General. History of flooding in the watershed has shown that floods occur at anytime of year. The floods of November 1927, September 1938 and August 1955 were caused by heavy rainfall, while the event of March 1936 was caused by heavy rainfall associated with warm weather and considerable snowmelt.

b. Historic Floods. Few records are available of serious flooding prior to 1927; however, the watershed experienced damaging flooding during February 1807, September 1828, May 1854, April 1869, October 1869, April 1895, March 1896 and February 1900.

c. Recent Flooding. In recent years, four significant floods have been experienced, and occurred in November 1927, March 1936, September 1938 and August 1955. Each event is described below.

(1) November 1927 Flood. A tropical storm formed over the Carribean late in October 1927, started northward 1 November and was at the lower end of Chesapeake Bay by 3 November. The storm followed a path over western Massachusetts and Vermont, causing the greatest flooding on the Vermont tributaries of the Connecticut River with serious flooding in New Hampshire and the western tributaries of Massachusetts. Storm rainfall was excessive in the Chicopee River watershed, causing the river to rise to above bankfull in many areas. Storm rainfall for 2-4 November at Ware, Hardwick and Hubbardston was 4.4, 4.5 and 4.1 inches, respectively, and the 24-hour rainfall at each of these stations was 4.1, 4.5 and 3.9 inches, respectively. Peak flows during this storm at the Ware River at Gibbs Crossing, the Swift River at Ware and the Quaboag River at West Brimfield were 14.3, 12.0 and 7.9 cubic feet per second per square mile of drainage area (csm), respectively. Total volume of runoff at the Gibbs Crossing gage for the period 3-10 November was 1.9 inches.

(2) March 1936 Flood. After the first week of March 1936, temperatures in New England became unseasonably warm and continued for the remainder of the month. Snow cover in the upper and central parts of the Connecticut River basin was above average as little thawing had occurred in January and February. During the period 9-22 March, three storm centers passed over New England, with heavy rainfall on 11-12 and 17-18 March. The total storm rainfall at Hardwick, Hubbardston and Ware were 7.3, 7.0 and 5.3 inches, respectively. Water equivalent of the snowmelt during this period was estimated at about 4 inches. Peak flows during this period at Chicopee River at Bircham Bend (drainage area = 704 square miles), Ware River at Gibbs Crossing, Swift River at Ware and Quaboag River at West Brimfield were 29.0, 52.3, 40.8 and 24.0 csm, respectively. For the month, approximately 9.8 inches total runoff passed the gage at Bircham Bend.

The Connecticut River at Hartford crested at 37.6 feet, the greatest flood in over 300 years of record, and from Fifteen Mile Falls to its mouth all previously known flood discharges were exceeded except in that part of the river just downstream of White River Junction, Vermont where the peak was less than that of the November 1927 flood.

(3) September 1938 Flood. This event produced the greatest flood of record along the Ware, Swift and Chicopee Rivers. Antecedent rainfall and runoff had filled many natural storage areas in the basin by the time of the most intense rainfall. As a result, the time sequence of this hurricane was conducive to high peak discharges. Total rainfall for the period 12-22 September for Hardwick, Hubbardston and Ware was 11.4, 15.6 and 12.8 inches, respectively. Maximum 24-hour rainfall at each of these stations was 5.4, 10.2 and 6.0 inches, respectively. Peak flows during this storm at the Chicopee River at Bircham Bend, the Ware River at Gibbs Crossing, the Swift River at Ware and the Quaboag River at West Brimfield were 64.2, 114.1, 29.5 and 56.1 csm, respectively. For the period 20-25 September 6.0 inches of runoff occurred at the Chicopee River at Bircham Bend. Plate G-42 shows the natural flood hydrograph and the hydrograph as modified by Barre Falls and Conant Brook Reservoir at three locations in the watershed.

This flood was the second largest on the lower Connecticut River and the greatest of record on many tributaries in the central and lower portions of the basin.

(4) August 1955 Flood. Although not as large as the 1938 event in most areas of the Chicopee watershed, the August 1955 flood produced the greatest flows of record along the Quaboag River. This event was brought about by two hurricanes occurring within a few days of each other. The first, hurricane "Connie", maintained a rather uniform rainfall rate during the period 11-14 August and, owing to dry antecedent ground conditions, did not produce an exceptional amount of runoff. The second storm, hurricane "Diane", produced intense rainfall from 17-20 August especially in southern portions of the watershed and caused serious flooding as a result. Rainfall totals for Ware and Springfield were 19.2 and 20.9 inches, respectively and maximum 24-hour rainfall for these two stations, respectively, were 14.0 and 11.5 inches on 19 August. Peak discharges at the Chicopee River at Indian Orchard, the Ware River at Gibbs Crossing and the Quaboag River at West Brimfield were 61.3, 80.7, 84.8 csm, respectively. Total runoff for the period 18-30 August at West Brimfield and Indian Orchard was 9.5 and 8.9 inches, respectively.

Plate G-43 shows the natural flood hydrograph and the hydrograph as modified by Barre Falls and Conant Brook Reservoirs at three locations in the watershed.

Due to the path of the storm, no heavy precipitation occurred above the Massachusetts-Vermont-New Hampshire state line, and the flooding occurred in the southern part of the Connecticut River basin. Record breaking floods occurred in many of the southern tributaries; and the Connecticut River at Hartford recorded the third highest stage- 30.6 feet for a discharge of 200,800 cfs.

## 12. ANALYSIS OF FLOODS

a. Chicopee River. The floods of record were analyzed in detail to determine the hydrologic development of floods in the Chicopee River watershed. The runoff characteristics of significant tributaries were appraised with a view of finding the relative timing and discharge contributions at the principal index points along the main rivers within the watershed, as well as the major damage centers on the Connecticut River. The analysis of record floods resulted in the following conclusions:

(1) Flooding may occur on the Chicopee River or its two principal tributaries, the Ware and Quaboag Rivers, at any time of the year.

(2) Major floods on the Chicopee River may be caused by large contriubtions from the Ware River as in September 1938 or the Quaboag River as in August 1955.

(3) A major flood occurring simultaneously on both the Ware and Quaboag Rivers could produce a Chicopee River flood exceeding any that has yet been experienced.

(4) The large surcharge storage in Quabbin Reservoir eliminates any appreciable contribution from the upper Swift River to downstream flood peaks.

(5) The upper Ware River receives a relatively high degree of protection from Barre Falls Reservoir and to a certain extent, by Coldbrook diversion. Below Barre Falls Dam, the middle and lower portions of the basin are capable of producing high runoff. This was illustrated by the August 1955 flood when the lower Ware River experienced the second greatest flood of record although the contribution from the upper part of the basin was minor.

(6) Numerous lakes and extensive valley storage in the Quaboag River watershed upstream of West Brookfield have a significant effect on reducng and retarding flood runoff. As a result, the contribution from this area to downstream flood crests is relatively small.

(7) Topography of the lower Quaboag River between West Brookfield and Palmer is conducive to the formation of high flood peaks. Many small streams, with relatively short times of concentration, enter the Quaboag River in this 11-mile reach. Runoff from these streams is primarily responsible for producing flood peaks on the Quaboag River at Three Rivers.

(8) Peak flow of the Quaboag River at Three Rivers usually precedes that of the Ware River by about 3 to 6 hours. However, there is a possibility that the two peaks could coincide, thereby producing higher stages at Three Rivers and along the Chicopee River. Runoff from the 30 square miles of the Swift River between Winsor Dam and the mouth attains its maximum rate of discharge at Three Rivers several hours before either the Ware or Quaboag Rivers.

(9) During large floods the peak discharge of the Chicopee River changes very slightly as the flood crest moves downstream from Three Rivers to its mouth.

b. Connecticut River. Flooding along the Connecticut River is caused be excessive rainfall, melting snow or a combination of both. Analyses of record floods reveal that Connecticut River floods have generally originated in one of the following manners: (1) as a general basinwide flood, usually with snowmelt, (2) in the northern portion upstream of White River Junction, (3) in the central portion between White River Junction and Montague City, and (4) in the southern portion downstream of Montague City. The November 1927 event occurred in the central and upper portions of the basin, the March 1936 flood was basinwide, the September 1938 flood originated in the lower and central portions of the basin, the flood of August 1955 was a lower basin event, and the April 1960 event was caused by considerable rainfall and snowmelt throughout the basin.

13. DESIGN FLOODS

a. Spillway Design Flood

(1) Barre Falls Design Criteria. As presented in the "General Design Memorandum" dated 1956, a maximum predicted storm upstream of Barre Falls Dam was determined based on Hydrometeorological Report 23 developed by the National Weather Service. The spillway design flood was determined by applying a computed 3-hour unit hydrograph to the maximum predicted storm. Total spillway design storm rainfall, 21-hour duration, was 22.36 inches (infiltration = 1.05 inches). The reservoir inflow and outflow peaks were 68,300 and 16,300 cfs, respectively, for the spillway design flood.

TABLE G-11

SPILLWAY DESIGN CRITERIA
BARRE FALLS DAM AND CONANT BROOK DAM

| Item | Barre Falls Design Criteria | Barre Falls 1967 Review | Conant Brook Design Criteria |
|---|---|---|---|
| Drainage Area (sq. mi.) | 55 | | 7.8 |
| **Spillway Design Storm** | | | |
| Basis of Design | HR #23, 28 | HR #33 | HR #33 |
| Volume of Rainfall (in.) | 22.4 | 20.1 | 24.4 |
| Total Losses | 1.1 | | 1.2 |
| Storm Duration | 21 | | 24 |
| **Unit Hydrograph** | | | |
| Unit Rainfall Duration (hrs) | 3 | 3 | 2 |
| Peak Flow (cfs) | 4380 | 4380 | 1,000 |
| **Spillway Design Flood (SDF)** | | | |
| Peak Inflow to Reservoir (cfs) | 68,300 | 61,000 | 11,900 |
| Volume of Runoff (ac-ft) | 65,200 | 55,500 | 9,650 |
| Peak Outflow (total cfs) | 16,300 | 14,500 | 11,000 |
| **SDF Reservoir Reg. Plan** | | | |
| Initial Pool Condition | Full | Full | 747 |
| Outlet Facility, During Flood | Closed | Closed | Operable |
| Max. Surcharge Elev. (ft msl) | 825 | 823.8 | 766 |
| **Freeboard Characteristics** | | | |
| Design Wind Velocity (mph) | 60 | 80 | 80 |
| Effective Fetch (miles) | 1.2 | 1.2 | 0.35 |
| Average Depth (ft) | -- | 25 | -- |
| Wave Runup (ft) | 4.1 | 4.5 | 2.2 |
| Wind Tide (ft) | 0.2 | 0.4 | Negligible |
| Adopted Freeboard (ft) | 5.0 | 5.0 | 5.0 |
| Top Elevation of Dam (ft msl) | 830 | 828.8 | 771 |

Spillway design requirements included: pool at spillway crest at start of spillway desin flood, gates closed during entire flood period and maximum wave heights occurring at time of maximum spillway discharge. A summary of design criteria for Barre Falls is presented in table G-11 and regulation during the spillway design flood is illustrated on plate G-44.

(2) Barre Falls 1967 Criteria. In April 1967, a review was made of the older reservoir projects to determine whether their hydrologic design criteria conformed adequately with current policies and criteria with respect to safety and functional reliability. Results of the Barre Falls re-analysis indicated that the original spillway design flood was more severe, and hence was sufficient to meet current design criteria. A summary of 1967 criteria for the spillway design flood is listed in table G-11.

(3) Conant Brook Design Criteria. "Design Memorandum No. 1", March 1963 computed a spillway design flood using a synthetic 2-hour unit hydrograph and a maximum predicted storm as determined from Hydrometeorological Report 33, dated April 1956 and prepared by the National Weather Service. Total maximum probable precipitation, 24-hour duration, was 24.4 inches (infiltration = 1.2 inches and rainfall excess = 23.2 inches). The reservoir inflow and outflow peaks were 11,900 and 11,000 cfs, respectively, for the spillway design flood.

This project is relatively new and the spillway design criteria is nearly the same as current criteria. A summary of design criteria is presented in table G-11 and regulation during the spillway design flood is illustrated on plate G-45.

b. Standard Project Flood. This design flood was prepared for the "Interim Report on Review of Survey, Chicopee River Basin, dated 8 September 1959; it was developed to demonstrate the flood producing potentiality of the basin, and also provide a basis for design of local protection projects. It was developed using standard project storm rainfall and unit hydrographs developed from an analysis of floods of record. Unit hydrographs used for the Chicopee River watershed exclusive of the upper reaches of the Ware River were derived from the August 1955 flood. On the upper reaches of the Ware River data from the September 1938 flood, which substantially exceeded the 1955 event, was used for the derivations of unit hydrographs.

A standard project storm for the watershed was centered on the drainage divide between the Ware and Quaboag Rivers. This location produced the most critical runoff conditions in the Chicopee River and was used to determine the most severe flooding in those areas where local protection was being considered.

Peak discharge of the standard project flood on the Chicopee River at Indian Orchard, Massachusetts is 77,800 cfs, which is nearly twice the peak of the 1955 flood of 40,500 cfs, and of the 1938 flood of 45,200 cfs.

Natural and modified hydrographs at selected locations for this flood are shown on plate G-46.

14. FLOOD DAMAGES

a. General. In the last 75 years, the three largest basinwide floods occurred in March 1936, September 1938, and August 1955. The events have been hydrologically described in previous paragraphs. The "Interim Report on Review of Survey - Chicopee River Basin," dated 8 September 1959, describes flood damage data for the 1938 and 1955 floods in Appendix C - Flood Losses and Benefits.

b. Experienced Losses. The following tabulation briefly summarizes experienced flood damage data in the respective year dollars for the 1936, 1938, and 1955 events along the Ware River from Barre to Three Rivers, and along the Chicopee River.

| Event | Experienced Flood Losses | | |
|---|---|---|---|
| | Ware River ($1,000) | Chicopee River ($1,000) | Total ($1,000) |
| March 1936 | 2,300 | 400 | 2,700 |
| September 1938 | 3,740 | 2,900 | 6,640 |
| August 1955 | 1,030 | 6,500 | 7,530 |

It is noted that all Corps flood control projects in the watershed were constructed after the 1955 flood. In addition, stage-damage curves based on field reconnaisance have not been updated since the 1959 Interim Survey Report was prepared.

c. Experienced Flood Levels or Discharge. Experienced flood conditions at selected index stations are summarized for reference purposes.

| Index Gage[1] | Drainage Area (sq.mi.) | Flood Event September 1938 | March 1936 | August 1955 |
|---|---|---|---|---|
| Coldbrook Div. | 96.8 | 14,000 cfs | 5,990 cfs | 652.4 ft msl |
| Barre Plains[2] | 115 | 590 ft msl | 583 ft msl | 577 ft msl |
| Gibbs Crossing | 199 | 22,700 cfs<br>18.2 ft stage | 11,200 cfs<br>12.0 ft stage | 12,200 cfs<br>12.8 ft stage |
| Indian Orchard | 688 | --- | --- | 40,500 cfs<br>22.1 ft stage |
| Bircham Bend | 703 | 45,200 cfs | 20,400 cfs | --- |

Notes:

(1) Additional information on the index gages associated with reservoir regulation activities can be found in paragraphs 18 and 30.

(2) The zero datum of the Barre Plains staff gage is at elevation 569.7 ft msl. This indicates the 1938 event reached a stage of about 20 feet at the gage.

d. Existing Benefit Analysis. Following each flood event, RCC determines the modifying effects of Corps projects at downstream locations. Natural flows and stages are computed for index damage zones along the Ware, Chicopee and Connecticut Rivers. The Economic and Social Analysis Branch of Planning Division determines benefits at each zone associated with reservoirs and local protection projects. A "Damage Prevented" form which is used by RCC and Economics Branch to compute benefits within the Connecticut River basin will be included in the Master Manual.

15. DROUGHTS

a. General. The Chicopee River watershed lies within the general zone classified as humid, and the average annual precipitation is distributed reasonably well throughout the year. In National Weather Service terminology, a drought is considered to be a period of 14 or more days in which less than 0.1 inch of precipitation falls in a 48-hour period. To the agriculturist, a drought is a lack of soil moisture during the growing season. Hydrologically, a drought is defined as a prolonged period of precipitation deficiency which seriously affects riverflow as well as surface and ground water supplies. Periods of deficient precipitation and runoff have occurred in the Chicopee River watershed.

b. History. The drought history in the watershed extends back more than 100 years. Several periods of below average precipitation have occurred prior to 1960, although no serious impact was made on the water needs of the area due to the sparse population and lack of industry in the region. The most notable of these occurred in 1880-1883, 1894, 1930, 1941 and 1949.

c. Drought of 1961-1966. The longest and most severe drought in the history of the Connecticut River basin is the one of 1961-1966. During this period, the cumulative precipitation deficiencies (i.e., total amount below normal) at Barre Falls and Ware, Massachusetts were 42.0 and 72.9 inches, respectively, which are 106 and 160 percent of the average annual precipitation. The cumulative runoff deficiencies for water years 1962-1966 at the Ware River at Gibbs Crossing, Quaboag River at West Brimfield and Chicopee River at Indian Orchard were 26.3, 28.9 and 36.8 inches, respectively, which are 130, 130 and 205 percent of the average annual runoff. Rarely is a deficiency of ground water carried over from one growing season to the next in New England, since it is replenished during each spring runoff. However, this condition occurred in the winter of 1964-1965 and resulted in a record low flow runoff at Ware River at Gibbs Crossing, and at the Quaboag River at West Brimfield of 7.4 and 9.4 inches, respectively, in water year 1965. These are 37 and 43 percent, respectively, of the average annual runoff (refer to plate G-30).

# CHAPTER IV

## COMMUNICATIONS

### 16. GENERAL

All communications between the project managers and RCC are made via the NED radio network during normal work hours or when NED headquarters are otherwise manned. Whenever the radio network is inoperative, communications are made by telephone. During nonwork hours, reports and regulation instructions are issued via telephone to or from the homes of WCB personnel. In the event of failure of the NED radio network and telephone service, emergency communications will be attempted through the State Police or Civil Defense radio facilities. In addition, radios in the Automatic Hydrologic Radio Reporting Network facilities in the field are tied directly to the RCC computer room serving as a backup system for normal radio communication. Location of the sites are listed in paragraph 19.

### 17. PRECIPITATION REPORTING NETWORK

Reports of precipitation data from the Chicopee River watershed are used primarily for the purpose of alerting RCC personnel and for providing a basis for appraising the severity of the storm. Collection and reporting of precipitation data from Barre Falls Dam is the responsibility of the project manager who also receives calls from observers in the watershed. Identification and location of these observers is given in the RCC telephone directory which is updated annually.

The Reservoir Control Center periodically reviews network arrangements to insure that an adequate reporting network is maintained. The Northeast River Forecast Center in Bloomfield, Connecticut receives precipitation reports from observers in and near the Chicopee River watershed, which are made available to RCC upon request. In addition, cooperative daily reporting procedures from most Corps dams have been established with the River Forecast Center and have been detailed in separate memos to each project manager.

### 18. RIVER REPORTING NETWORK

a. General. A network of river stage observation stations, which is part of an overall river reporting system for the Connecticut River basin has been established. This network assists in the execution of the reservoir regulation plan by permitting personnel in RCC and at the dams to obtain river stages at selected key index stations located on tributaries or on the Connecticut River.

b. River Reporting System. The Corps existing reporting system for regulating Barre Falls Dam includes:

USGS gaging station at Barre
Staff gage on the Route 32 highway bridge in Barre Plains
USGS gaging station at the Coldbrook Diversion
USGS gaging station at Indian Orchard
USGS gaging station at Montague City
NED gaging station at York Street pumping station -Springfield
NWS gaging station at Bulkley bridge - Hartford

A brief discussion on each follows:

(1) Ware River at Barre. The USGS gaging station at Barre (plate G-35) measures runoff from the 55 square miles of the upper Ware River watershed controlled by Barre Falls Dam. This gage is located on the left bank about 700 feet downstream from the dam and has been in operation since July 1946. Data from this gage is read remotely from the gate house.

(2) Ware River at Barre Plains. This staff gage, located on the downstream side of the center pier of the Route 32 highway bridge (drainage area - 115 square miles), is an indicator of stage in the low lying area along the Ware River between South Barre and Wheelwright. Observations at this location are requested by RCC from the project manager during high flows.

(3) Ware River at the Coldbrook Diversion. This USGS gage is on the right bank of the Ware River above the diversion structure. Runoff from the upper 96.8 square miles of drainage area of the Ware River watershed is measured and recorded here.

(4) Chicopee River at Indian Orchard. The USGS gaging station at Indian Orchard is located on the left bank of the Chicopee River approximately 7 miles above the mouth. This gage records the runoff from 688 of the 721 square mile watershed. The gage is presently telemark equipped and is also included in the Automatic Hydrologic Radio Reporting Network. The rating table for this location is included on plate G-34.

(5) Connecticut River at Montague City. The USGS gage at Montague City is located on the left bank of the river 75 feet downstream from the NYNH&H Railroad bridge at Montague City and 1,000 feet downstream from the mouth of the Deerfield River. This gage records runoff from 7,865 square miles, is telemark-equipped and also reports via the AHRRN. The rating table for this gage is included on plate G-31.

(6) Connecticut River at Springfield. This gage (plate G-32) is on the left bank at the York Street pumping station, approximately 4,500 feet downstream from Memorial bridge and about 3,000 feet

above the confluence of the Westfield and Connecticut Rivers. During flood periods, it is used to measure stages associated with runoff from a drainage area of 9,587 square miles, including the Westfield River watershed. Data from the gage is automatically transmittted via the AHRRN.

(7) Connecticut River at Hartford, Connecticut. The gage (plate G-31) on the Connecticut River is located on Bulkley bridge in Hartford and is in a natural storage reach, resulting in a hysteresis curve for the stage-discharge relationship. This station has an area of 10,428 square miles, is telemark-equipped and reports via AHRRN to the Reservoir Control Center.

C. Future Plans

Paragraph 19 and 20 discuss the collecton of hydrologic data by means of a radio reporting network. When and if the GOES system becomes "operational", RCC will consider locating DCP's at the Route 32 bridge in Barre Plains and also at the USGS gaging station on the Ware River at Gibbs Crossing. This gage has an area of 199 square miles and is located in Ware approximately 25 river miles downstream of Barre Falls Dam.

19. AUTOMATIC HYDROLOGIC RADIO REPORTING NETWORK

The effective regulation of flood control projects in New England, consisting of 35 flood control dams and four hurricane barriers, requires reliable and rapid method of collection and coordinating hydrologic data by the Reservoir Control Center. In January 1970, the installation of an Automatic Hydrologic Radio Reporting Network (AHRRN) was completed. Radio gaging stations have been established at the following locations in the Connecticut River basin:

Connecticut River at Wells River, Vermont
White River at West Hartford, Vermont
Connecticut River at West Lebanon, New Hampshire
Connecticut River at North Walpole, New Hampshire
Ashuelot River at Keene, New Hampshire

Deerfield River at West Deerfield, Massachusetts
Connecticut River at Montague City, Massachusetts
Chicopee River at Indian Orchard, Massachusetts
Westfield River at Westfield, Massachusetts

Connecticut River at Springfield, Massachusetts
Mad River Lake at Winchester, Connecticut
Farmington River at Unionville, Connecticut
Farmington River at Rainbow, Connecticut
Connecticut River at Hartford, Connecticut

Details of the computer controlled radio hydrologic reporting network are covered in a report prepared by RCC in August 1976, entitled: "Flood Control Automatic Hydrologic Radio Reporting Network." Plate G-47 shows a computer printout of a typical interrogation.

20. DATA COLLECTION BY SATELLITE

In June 1972, NED entered into a contract with the National Aeronautic and Space Administration (NASA) for an experiment to study the feasibility of using the Earth Resources Technology Satellite (ERTS, later referred to as LANDSAT) for collecting hydrologic data from about 20 stations in New England. Many of these stations were USGS gages. A major objective of this experimental program was to compare the cost, reliability and operational effectiveness of the LANDSAT data collection with the existing NED (AHRRN) radio network. A final report, issued in March 1975, stated the concept was economically feasible and operationally reliable; however, more frequent reporting times would be required for an operational system. In 1975 as an outgrowth of this work, NED installed a ground receive station consisting of a 15-foot parabolic antenna and satellite tracking equipment.

In August 1977, NED investigated the capability of receiving hydrologic data via GOES, a geostationary operational satellite operated by NOAA, employing NED's existing 15 foot downlink. Approval was obtained from OCE in September 1977 to procure a GOES receive station and to purchase data collection platforms. Conversion of the downlink was performed in 1978 and the system is now capable of receiving data from LANDSAT or GOES and contains dual minicomputers to accomodate the GOES data collection. Plans are underway for purchase of 50 GOES DCP's during FY 1979, pending OCE approval.

21. REPORTS

a. Weekly Reports. The project manager makes a routine report via radio (or telephone) to RCC each Friday morning. This report insures continuous contact between field personnel and RCC, and also serves as a check on the communications network. The report includes the preceding 24-hour precipitation, current weather conditions at index stations and other miscellaneous data. A sample of a completed Friday morning report is shown on plate G-48.

b. Alerting Reports. An alerting report is promptly made and should include pertinent data that is readily obtained together with a general appraisal of local conditions although data from all precipitation or index gaging stations may not be available. Whenever any of the following conditions occur, the manager will immediately notify RCC:

(1) Precipitation. Occurrence of 1-inch precipitation or other amount as indicated by RCC during any 24-hour period at Barre Falls Dam.

(2) Reservoir Stages. A reservoir stage of 776 feet msl and rising during the nonfreezing season or 780 feet and rising during the freezing season at Barre Falls Dam.

c. Supplemental Reports. Supplemental radio (or telephone) reports are made to RCC by the manager either following instructions from RCC or if it appears that flood conditions might develop in the watershed as the result of meltiing snow, ice jams, dam failures or heavy localized rainfall. The time and frequency of these reports are dependent upon the severity of conditions and specific instructions from RCC. Plate G-49 shows a typical reporting log, indicating the data to be included in reports by the project manager during flood periods. The following information is included in the flood report to RCC.

(1) Precipitation at Dam. The total amount of precipitation which has fallen up to the time of reporting and several intermediate amounts with times of observation, as indicated by RCC.

(2) Reservoir Stage. The pool stage at time of reporting and several previous readings with corresponding times to determine the rate of rise and define the inflow hydrograph. Accurate readings of stage and time are essential to facilitate computation of inflow (see plates G-50 through G-52).

(3) Gate Positions. Gate openings and discharges at time of reporting and at beginning of storm. Any gate changes since preceding report should be included with corresponding stage and discharge.

(4) Precipitation Reports from Observers. Rainfall data received from watershed observers.

(5) River Stages. Ware and Chicopee River stages with times of observations from gages at Coldbrook Diversion, Barre Plains, and Indian Orchard as requested by RCC.

(6) Snow Cover. General snow cover which may affect runoff conditions throughout the basin.

(7) Miscellaneous Data. Any other information which might be pertinent such as temperature, etc.

d. Special Reports. A special report is submitted by the manager to RCC whenever unusual circumstances occur during a flood or as requested by RCC. The report may be written in longhand and should describe the subjects outlined below if appropriate.

(1) Observations at Dam. The manager makes general observations of conditions occurring at the outlet works as listed on the following page. The observations are entered in the log book at the dam. If possible, photographs are taken of any unusual conditions, noting data, time, reservoir gage heights and position of the gates. Observations which should be reported to RCC are:

(a) Extent and action of eddies, waves or whirlpools in the vicinity of the conduit intakes and portals.

(b) Extent and action of turbulence or eddies downstream of the spillway and outlet works.

(c) Effect on flow through the gates due to an accumulation of ice or debris at the intake.

(d) Pool elevation and position of gates where gate vibration or whirlpools develop.

(e) Any seepage - noting time, pool stage, and color of discharge. Embankment sloughing which may appear at the downstream sides of the dam or dikes should also be reported.

(f) Any other unusual hydraulic phenomena that may occur.

Observations at Conant Brook will be made by the Westville Lake project manager at the request of RCC.

(2) Observations at Downstream Control Points. During periods of reservoir impoundments, particularly while emptying the reservoir, reconnaissance of downstream conditions is made by either the project manager or his assistant upon specific authorization from RCC. This is done to obtain further flood data in the downstream damage areas or index points along the Ware, Chicopee or Connecticut Rivers.

e. Snow Survey Reports. Snow courses have been established at selected locations within the upper watershed (table G-5). Weekly surveys are made by the managers during winter and early spring to determine the depth of snow and equivalent water content. Dates for surveys are determined each year by RCC so as to correspond with monthly bulletins of the U.S. Geological Survey and supplemental data from State agencies and power companies. The reports contain the name of the station, snow depth and water equivalent. Average, maximum and minimum water equivalent of snow cover in the Chicopee River watershed are shown on plate G-28.

f. Northeast River Forecast Center Reports. The project manager at Barre Falls Dam will make a daily telephone call at 0815 hours to the Northeast River Forecast Center (NERFC) to report hydrologic and climatologic conditions at the dam. The following parameters will be reported on a daily basis:

| | |
|---|---|
| Dam | Depth of new snow |
| Date | Total depth of snow |
| Time of observation | Temperature - max. preceding 24 hours |
| Precipitation (24 hours) | Temperature - min. preceding 24 hours |
| Present weather | Temperature - current |

The above data is used to develop a Chicopee River headwater statement. The statement, transmitted by NERFC to RCC twice weekly, gives the amount of rainfall in six hours required to produce runoff varying from .25 to 5 inches into Corps reservoirs.

22. SPECIAL ADVISORIES

In accordance with regulations set forth in EM 550-1-1, "Domestic Emergency Operations", and the "Guidance Memorandum, Reservoir Control Center", special advisories from RCC on flood potential and progress of all threatening storms are submitted to the Division Engineer and to the Chief of Engineering and Operations Divisions. Flood reports are also prepared for OCE by RCC.

23. MAINTENANCE OF LOG

All reports, instructions, records of unusual circumstances at the dam, and information pertinent to regulation of the reservoir are entered in the logs (plate G-49). Logs are maintained by the project managers and Reservoir Control Center.

24. GATE OPERATION RECORD

All gate operations are carefully noted on NED Form 90 (plate G-53) and submitted bimonthly to RCC. All operations are noted regardless of the duration of the change in gate position. The report includes data and time of day, reservoir stage, outflow, precipitation, gate opening, tailwater reading and remarks column. RCC personnel utilize the Form 90's in the preparation of the monthly charts of reservoir regulation, which serve as permanent records of reservoir regulation. Form 90's are also utilized in the preparation of yearly reservoir regulation exhibits for the RCC Annual Report, which is forwarded to OCE, NED personnel, other agencies, and the public.

## CHAPTER V

## HYDROLOGIC FORECASTS

25. NATIONAL WEATHER SERVICE

a. Weather Forecasts. The National Weather Service in Boston, Massachusetts is responsible for issuing daily weather forecasts for public dissemination through the news media. These reports are received at RCC approximately four times each day on the Weather Service teletype loop.

b. Precipitation Forecasts. In addition to the normal weather forecasts, quantitative precipitation forecasts are received daily by RCC. Supplemental weather information and forecasts prior to or during floods are made available upon request.

c. River Forecasts. The Northeast River Forecast Center at Bloomfield, Connecticut is responsible for preparing and disseminating flood forecasts for the Connecticut River and some of the principal tributaries. Flood forecasts in the Connecticut River basin are listed for the following locations:

Connecticut River at N. Stratford, New Hampshire
Connecticut River at Dalton, New Hampshire
Connecticut River at Wells River, Vermont
Connecticut River at White River Jct, Vermont
Connecticut River at N. Walpole, Vermont
Connecticut River at Montague City, Massachusetts
Connecticut River at Thompsonville, Connecticut
Connecticut River at Hartford, Connecticut
Connecticut River at Bodkin Rock, Connecticut
Passumpsic River at Passumpsic, New Hampshire
Ammonoosuc River at Bath, New Hampshire
White River at West Hartford, Vermont
Chicopee River at Indian Orchard, Massachusetts
Farmington River at Rainbow, Connecticut

26. CORPS OF ENGINEERS

a. Chicopee River Forecasts. During flood periods in the Chicopee River watershed, Barre Falls Dam is principally operated to provide protection to communities downstream on the Ware River. Experience at Barre Falls has shown that regulating for a stage of 2.5 feet at the Barre Plains gage (peak travel time from the dam - 5 to 7 hours) during the growing season and 5.5 feet during the nongrowing season will adequately protect these communities.

While regulating Barre Falls when the Coldbrook intake is diverting, consideration should be given to the effects these diversions have on releases from Barre Falls. Peak flow travel time from Barre Falls to Coldbrook is 3 to 4 hours.

During high flows, the travel time of releases from Barre Falls to the Chicopee River at Indian Orchard is about 21 hours. As a result of this extensive travel time and the large intervening drainage area between the dam and Indian Orchard, the effects of regulation at Barre Falls will usually be minimal along the Chicopee River.

Therefore, considering that releases from Barre Falls are governed by stages at Barre Plains and that they have little effect on the Chicopee River, it has not been considered necessary to develop specific flood forecasting procedures for the Chicopee River watershed. In addition, RCC continually receives weather, quantitative precipitation and flood forecasts from the National Weather Service and data from the automatic hydrologic radio network and the other 25 manned dams.

b. <u>Future Flood Forecasts</u>. In December 1971, the Reservoir Control Center requested the Hydrologic Engineering Center to develop a flood forecasting technique for the Merrimack River basin based on "real time" data collected from the Automatic Radio Reporting Network, flood control dams and other sources. This technique has been developed for in-house use and further refinement, and may be utilized in developing forecast procedures for the Connecticut River basin.

# CHAPTER VI

## RESERVOIR REGULATION

### 27. PLAN - GENERAL OBJECTIVES

The general objective of the regulation procedures for the Chicopee River watershed is to provide a comprehensive tool for guiding those responsible for operating Barre Falls Dam in accomplishing the missions for which this project was authorized. This plan will allow for the most efficient protection of immediate downstream communities on the Chicopee River and its tributaries, as well as communities further downstream on the Connecticut River.

### 28. NONFREEZING SEASON

Barre Falls Dam is authorized as a dry bed reservoir and will have a normal gate setting during the nonfreezing season of 2′-2′.

### 29. FREEZING SEASON.

A winter pool will be maintained at Barre Falls Dam at an elevation between 776 and 778 feet msl to prevent freezing of the flood control gates. The pool will be developed gradually with some water being released continually. Once the pool is established the project manager will make small adjustments (maximum gate opening at each gate not to exceed 2 feet) in gate openings to maintain the pool at a relatively constant level. RCC will instruct the project manager when the winter pool is to be established in the fall and lowered in the spring.

If a winter pool at Barre Falls continues to rise above 780 feet with 2-foot gate openings, the Reservoir Control Center will be contacted with an alerting report.

### 30. FLOOD CONTROL

a. Objective. Flood control objectives of Barre Falls Dam are directed to primarily provide flood protection to downstream communities on the Ware River, and secondly, for communities on the Chicopee and Connecticut Rivers.

b. Regulating Constraints.

(1) Minimum Releases. A minimum release of about 10 to 20 cfs will be maintained during periods of flood control regulation in order to sustain downstream fish life.

(2) Flowage Easement in Reservoirs. Land is owned in fee to elevation 815 feet msl at Barre Falls Dam and 762 feet msl at Conant Brook Dam; this is 8 and 5 feet above spillway crest for Barre Falls and Conant Brook, respectively. It is possible that adjacent lands which are above fee taking could become inundated during a rare flood. Observations will therefore be made periodically by the responsible project manager or assistants to determine if any development has occurred in these areas which could be affected, and if so RCC should be notified.

(3) Downstream Developments.

(a) Ice Jam Flooding. When ice jamming is a possibility in the Ware River, observations should be made to determine if releases from the project are affected by downstream ice jams, hence creating problems along the river. In the past, ice jams have occurred on the Ware River at Ware in the vicinity of the Church Street bridge, on the Hardwick-New Braintree town line at the Hardwick Road Bridge, and the railroad bridge immediately upstream of Gilbertville.

(b) Structural Constrictions. Project personnel should periodically reconnoiter downstream conditions to determine if there is any development, debris or other physical restrictions which might reduce nondamaging channel capacity along the Ware River downstream of Barre Falls Dam.

31. FLOOD PERIOD

a. General. Regulation of flows from Barre Falls Dam are initiated for heavy rainfall over the Ware and Chicopee River watersheds and also for specific river stages at key index stations in the Chicopee River watershed and along the Connecticut River. These stations are discussed in paragraph 18. Regulation may be considered in three phases during the course of a flood. Phase I - the appraisal of storm and river conditions during development of the flood leading to the initial regulation, Phase II - regulation of the project while the Ware and Chicopee Rivers and/or Connecticut River floodflows crest and move downstream; and Phase III - emptying the reservoir following downstream recession of the flood. The standard operating procedures (SOP) for regulating Barre Falls are shown on Plate G-54.

b. Phase I - Appraisal, Initial Regulation. During this phase it is important to collect rainfall and discharge data in order to appraise the development and magnitude of a flood in the basin.

Also during Phase I, gate operations at Barre Falls Dam will be initiated to restrict the reservoir discharge. Consideration will be given to partial closure of the gates at Barre Falls (1′-1′) for any of the following conditions:

(1) Whenever a rainfall of 2.0 inches on snow-covered, wet, or frozen ground or 3.0 inches on dry ground occurs within a 24-hour period.

(2) Whenever the stage at the staff gage at Barre Plains reaches a stage of 1.5 feet and rising during the growing season or 3.5 feet and rising during the nongrowing season.

(3) Whenever the stage at the USGS gage at the Chicopee River at Indian Orchard reaches 8.0 feet and rising. A stage discharge table is shown on plate G-34.

c. Phase II - Continuation of Regulation. An important regulation activity during this period is the collection of hydrologic data such as: (1) precipitation amounts throughout the watershed as well as surrounding areas, (2) snow cover and water content in case of snowmelt floods, (3) stage and discharge values at downstream control points, (4) status of the Coldbrook Diversion and (5) other streamflow data which would assist in the regulation. During this phase, the reservoir discharge is regulated to reduce downstream flooding on the Ware, Chicopee and Connecticut Rivers.

As a flood develops, considerable judgment and experience are necessary to vary the regulation in accordance with the amount of residual reservoir storage at Barre Falls, river stages, water content of the snow remaining in the watershed and weather forecasts. In general, continuation of regulation will be governed principally by the riverflows at Coldbrook Diversion, Barre Plains, and Indian Orchard.

Secondary river rises from additional rainfall or snowmelt will be considered applicable to Phase II. With rising stages at Barre Plains consideration will be given to travel times from Barre Falls to Barre Plains in order to anticipate river stages. Approximate peak flow travel times to downstream index stations follow:

| Barre Falls Dam to | Hours |
|---|---|
| Coldbrook Diversion | 3-4 |
| Barre Plains | 5-7 |
| Three Rivers | 18-20 |
| Indian Orchard | 22-26 |

The preceding conditions will usually govern the continuation of regulation in Phase II, but in some cases flood conditions on the Connecticut River will be the controlling factor. Generally, regulation in Phase II will continue until flow has receded to safe channel capacity along the Ware and Chicopee Rivers and at Springfield on the Connecticut Rivers.

Consideration will be given to complete closure of the gates at Barre Falls (0'-0.1') and for any of the following conditions:

(1) Whenever a rainfall of 3.0 inches on snow covered, wet or frozen ground, or 4.0 inches on dry ground occurs within a 24-hour period.

(2) Whenever the river stage at Barre Plains reaches 2.0 feet and rising during the growing season or 4.0 feet and rising during the nongrowing season.

(3) Whenever the stage at the USGS gage at Indian Orchard reaches 10.0 feet and rising.

(4) Whenever the Connecticut River (plate G-31) is rising and approaches the following stages:

| Station | Feet | CFS |
|---|---|---|
| Montague City | 26 | 68,800 |
| Springfield | 18 | 126,000 |

d. Phase III - Emptying the Reservoirs. Following recession of the flood peak at downstream communities on the Ware, Chicopee and Connecticut Rivers, Barre Falls Reservoir will be emptied as rapidly as possible in accordance with instructions issued by RCC. Releases will normally be made in a manner which will not cause the stages downstream to exceed the conditions listed below. Consideration should also be given to the diversions at the Coldbrook Intake.

| | Growing Season | | Nongrowing Season | |
|---|---|---|---|---|
| Station | Stage in Ft. | Flow-cfs | Stage in Ft. | Flow-cfs |
| Barre Plains | 2.5 | - | 5.5 | - |
| Indian Orchard | 12.0 | 9,710 | 12.0 | 9,710 |
| Springfield | 18.0 | 126,000 | 20.0 | 151,000 |

Rating tables for these and other gaging stations are shown on plates G-31 through G-35.

Other phase III considerations include:

(1) The rate of increase in discharge from Barre Falls Dam should not exceed 150 cfs per hour up to 600 cfs, and 50 cfs per hour over 600 cfs, with the maximum rate of reservoir drawdown not to exceed about 5 feet in 24 hours.

(2) Discharge at Barre Falls Dam will be coordinated with releases from other reservoirs in the system in a manner that will

allow the Connecticut River flood crests to continue receding. This subject will be described in detail in the "Master Regulation Manual for the Connecticut River Basin."

(3) During the growing season from April to October agricultural lands along the Ware River in Hardwick from the Hardwick Road bridge to the Boston & Maine Railroad (a length of almost 4 miles) become inundated when river levels reach about 2.5 feet at the Barre Plains gage (Plate G-55). In addition, agricultural lands along the Connecticut River become inundated when the river level at Springfield rises to about 18 feet. This should be considered when regulating for floods during the growing season. Under such circumstances, a reconnaisance may be requested by RCC and appropriate action taken. However, it is noted the primary purpose of the projects is the protection of major downstream industrial, commercial, and residential communities such as Springfield, West Springfield, East Hartford and Hartford, and that it is important to try to avoid uncontrolled spillway discharge from Barre Falls.

(4) The maximum nondamaging channel capacity immediately downstream of Barre Falls is 1,000 cfs during the nongrowing season. This rate of discharge should be considered by RCC whenever peak inflows have exceeded these values, and climatologic and hydrologic conditions permit. Outlet rating curves for Barre Falls Dam and Conant Brook are shown on plates G-56 and G-57, respectively.

(5) Secondary river rises during Phase III, due to either additional rainfall or snowmelt, may result in regulation procedures reverting to Phase II.

(6) With Barre Falls filled to spillway crest and an inflow of 3 cubic feet per second per square mile (csm) it would require about 14 days to empty the reservoir using a release rate of 1000 cfs.

e. Regulation for Snowmelt. Moderately high springtime discharges can occur as a result of melting snow, but runoff from this source alone has not caused major flooding. Snow cover in the lower elevations of Massachusetts and Connecticut usually diminishes before melting takes place in the northern areas of Vermont and New Hampshire, however, the potential snowmelt flood threat period on the Connecticut River and its tributaries is prolonged and generally occurs in March and April due to high riverflows and saturated ground conditions.

Active snowmelt begins when density of the snowpack rises above 30 percent, i.e., a 10-inch depth of snow having 3 inches of water equivalent. RCC has not developed precise correlations regarding high temperatures - snow density-peak runoff relationships for each tributary. However, operating experience has indicated that after the snowpack becomes "ripe", several days of maximum temperatures in the fifties and sixties would result in flows of up to 8 to 10 csm in the main stem of the Chicopee River and discharges up to 20 csm from the smaller, steeper tributaries in the watershed. Runoff from snowmelt alone is diurnal, orderly and gradual, and regulation by RCC personnel will not necessarily follow the release guides established for runoff associated with rainfall. Regulation during periods of snowmelt with no rainfall occurring or expected to occur generally will be based on maintaining releases consistent with full downstream channel capacities.

f. Spillway Discharges. During a major flood the gates will not ordinarily be opened to avoid spillway discharge. Surcharge storage above the spillway crest will be utilized if the downstream channel capacity continues to be exceeded by runoff from uncontrolled areas.

If the stored floodwaters in Barre Falls reservoir continues to rise above the spillway crest with the possibility of the pool exceeding the maximum design surcharge, the following schedule will be used as a guide for gate releases during spilway discharges. This schedule will result in the gates being fully open when the pool has reached about two-thirds design surcharge.

| Barre Falls Dam | |
|---|---|
| Pool Elevation (ft msl) | Gate Openings |
| 807 | 0′-0′-0.1′ |
| 812 | 2′-2′-2′ |
| 818 | 3′-3′-3′ |
| 824 | 5′-5′-5′ |
| 830 | 9′-9′-9′ (fully open) |

It should be emphasized that this would result from an extremely rare event, occurring after more than 20 inches of rainfall in 24 hours, with the reservoir full or nearly full at the beginning of the storm event. Spillway rating curves are shown on plates G-58 and G-59 for Barre Falls and Conant Brook.

g. Alerting of Flood Affected Populace. Whenever it is anticipated that Barre Falls reservoir will rise above spillway crest elevation during an extreme flood, the project manager will notify the Massachusetts State Police at the Holden Barracks; the Chiefs of Police at Hardwick, Barre, New Braintree, Ware and West Brookfield; and the operator at the Coldbrook intake. The Police Chiefs at Barre and Hubbardston should also be warned that portions of their communities might be inundated from water backing up from Barre Falls Dam. Telephone numbers for these and other local officials are listed in the RCC telephone directory which is updated annually.

h. Effect of Regulation on Roads within the Reservoirs. There are several roads that pass in or through the reservoir areas at Barre Falls Dam that are subject to inundation during the storage of floodwaters. Inasmuch as public safety is involved in the use of these roads, the project manager is responsible for barricading the roads when necessary. These are all closed when a rising pool reaches 783.5 feet msl. Locations of these barricades are shown on plate G-4.

32. EXTRAORDINARY FLOOD CONDITIONS

It is conceivable that extraordinary circumstances or unpredictable flood conditions may arise such as a possibility of drowning, dam or bridge failures, highway or railroad washouts, ice jams or debris deposits. Since the purpose of the reservoirs is to save lives and prevent or reduce damage, regulation during such unusual conditions may not follow previously described rules but will be governed by the urgency of the circumstances. During such conditions the project manager has full authority to act immediately in the public interest. RCC will be notified as soon as possible of any unusual incident so that additional action may be taken to provide maximum protection.

33. REGULATION WITH FAILURE OF COMMUNICATION

Should the Barre Falls project manager be unable to contact RCC when a flood is developing, he has full authority to act promptly in accordance with instructions contained in the EOP and will direct regulation of the reservoir until communications can be re-established with RCC (refer to plate G-54 and paragraph 34). It snould be emphasized that whenever communications fail, or due to lack of adequate reports, it is difficult to fully appraise runoff from an intense storm, then it is preferrable for the project manager to immediately restrict or completely stop reservoir discharges rather than to delay regulation and contribute to downstream flood conditions.

In cases of extreme emergency, the manager shall attempt to communicate with RCC through the Massachusetts State Police and the office of Civil Defense Mobilization radio networks. In addition, all hydrologic radio reporting stations have radios that transmit directly to RCC. Paragraph 19 lists the location of these stations.

The project manager will regulate discharges from the reservoir during Phase I. In case of doubt as to whether a partial or complete closure should be made, the gates will be closed completely whenever the severity of the storm and/or lack of information concerning downstream conditions warrant such action.

Releases for emptying the reservoir will not be made until contact has been established with RCC. Possession of instructions contained in this manual does not relieve the project manager of his responsibility for continued efforts to communicate with RCC.

34. EMERGENCY OPERATING PROCEDURES (EOP)

When unable to contact RCC and flood conditions develop, the Project Manager or his assistant have full authority to regulate the gate openings in accordance with instructions as follows:

EMERGENCY OPERATIONS PROCEDURE

| Condition | Partial Closure (1.0′-1.0′) | Complete Closure (0.0′-0.1′) |
|---|---|---|
| Rainfall in 24 hours | 2.0 inches | 3.0 inches |
| Barre Plains | 1.5 feet | 2.0 feet |
| Indian Orchard | 8.0 feet | 9.0 feet |

Emptying the reservoir will not be initiated until contact has been established with RCC.

35. COOPERATION WITH DOWNSTREAM WATER USERS

It is policy of the Corps of Engineers to cooperate with downstream water users and other interested parties or agencies. The Barre Falls project manager may be requested by downstream users to deviate from normal regulation for short periods of time. Whenever a request for such modification is received, the manager shall ascertain the validity of the request and require the individual making the request to obtain assurance from other downstream water users, that they are agreeable to the proposed operation. The manager will then relay the information to RCC and request instructions. A minimum release from Barre Falls for downstream fish life shall always be maintained during periods of regulation.

36. ABSENCE FROM DAM

RCC and the basin manager are notified whenever the project manager expects to be away from the dam either overnight or for an extended period.

37. SEDIMENTATION

Sedimentation ranges and monuments have not been installed in either Barre Falls or Conant Brook reservoir areas. However, experience at several other Corps dry bed reservoirs in New England has shown that only minimal amounts of sedimentation can be expected.

38. FUTURE STUDIES

Post flood studies will be made after all reservoir regulation periods to determine efficiency of communications and reporting networks; applicability of regulation guides, including stage-discharge relationships and discharge correlations, and flood reductions at damage centers.

39. WATER QUALITY ACTIVITIES

a. General. There is no storage of water at Barre Falls or Conant Brook Dams specifically for management or control of downstream water quality. Although water quality control is not an authorized project purpose, compliance with Executive Order 11752 requires that all Federal facilities shall be managed so as to protect and enhance the quality of water resources through compliance with applicable standards for the prevention, control and abatement of environmental pollution in full cooperation with State and local Governments.

Monitoring of reservoir inflows, impoundments and discharges is accomplished on a periodic basis. Data is collected for many physio-chemical parameters and a limited number of bacteriological and biological parameters. Monitoring and analysis are currently under the administrative and management control of Operations Division. Summaries of their water quality analyses and activities are included in an annual report to OCE, as required under the provisions of ER 1130-2-334. Sampling and analysis of water quality is also being performed in the interest of public health associated with water supply and recreation activities at the projects in accordance with ER 1130-2-407 and other existing guidance.

b. Barre Falls Dam. The quality of water passing through the dry bed reservoir has been monitored since 1970 although not on a regular basis. Dissolved oxygen measurements made during this period indicate a level at all three sampling stations (two upstream and one downstream from the dam) at or above the 90 percent of saturation level.

Chemical characteristics of the Ware River in the project area reflect the presence of the significant number of swamps located upstream from the dam. The mean pH values vary at the three sampling stations from 5.9 to 6.1. The water is colored and has elevated concentrations of ammonia, phosphate, iron and possibly zinc; the data on this latter metal are not conclusive. High levels of iron and zinc may be due to the acidic nature of the water and the complexing tendencies of these metals with humic substances found in waters that have passed through swamps.

During the monitoring period, coliform bacteria samples were collected at the station downstream from Barre Falls Dam. Analysis of these samples showed high counts of coliform, a significant portion of which could be influenced by vegetative sources. However, a large value for fecal coliform bacteria counts indicated that some mammalian, possibly human, source is also present.

The existence or operation of Barre Falls Dam does not influence the quality of water in the Ware River.

c. <u>Conant Brook Dam</u>. Water quality monitoring at Conant Brook includes eight station in Conant Brook; however, only two stations have been monitored continuously since 1970. These two are at Vinica Brook, the main tributary to Conant Brook, and at the discharge of Monson Reservoir immediately downstream from Conant Brook dam.

Dissolved oxygen measurements in Conant Brook below Monson Reservoir were usually greater than 75 percent of saturation. However, samples taken during this period do not include any taken early in the morning when dissolved oxygen levels are usually lowest.

Chemicals analysis of the samples taken from Conant Brook indicate a water with high levels of iron and manganese. Other water quality parameters measured show that the water in Conant Brook is soft with low alkalinity, has some color but low turbidity, a mean pH of 6.3, low dissolved solids content, and low levels of metals other than iron, manganese, and possibly, zinc.

Nutrient concentrations in Conant Brook proved to be phosphorous limited with phosphate levels close to the threshold level for algae blooms to occur. Inorganic nitrogen levels, however, were considerably higher than the level considered critical for algae bloom.

Conant Brook Dam does not influence the quality of water in Conant Brook.

# CHAPTER VII

## HYDROLOGIC EQUIPMENT

### 40. PRECIPITATION GAGE

A standard weighing and recording NWS precipitation gage has been installed at Barre Falls Dam and serves as a supplement to other NWS rainfall stations within or in the vicinity of the Chicopee River watershed.

The project manager or his assistant should check this gage daily to determine if it is operating properly and also to record any precipitation occurrence in the last 24 hours.

### 41. RESERVOIR STAGE RECORDER

The automatic float-operated water level recorder at Barre Falls traces the water level in the reservoir at all times. Recording instruments should be checked each morning to assure the clock is keeping correct time and the pen is tracing properly. Any discrepancies in the record as evidenced by the pen time or gage heights should be noted on the chart and the instrument reset. During periods of reservoir storage, the outside tile or staff gage should be read to check tape readings and/or chart records. Should the recorder become inoperable, the USGS should be notified and arrangements made to repair the instrument; RCC should also be notified.

The chart record should be changed the first working day of each month at Barre Falls and the following information noted in ink at the beginning and end of each chart:

Outside (tile) gage reading
Pen gage height reading
Watch time
Pen time
Date and name of dam

Conant Brook dam is equipped with a bubble gage recorder which continuously measures and records the pool levels. This gage is housed in a concrete structure on top of the dam. The Project Manager of Westville Lake checks this recorder weekly and replaces the pool chart monthly. Pool charts from Conant Brook are sent to RCC for use in preparing monthly pool charts and then returned to Westville Dam where they are kept on file.

42. TAILWATER GAGING STATIONS

A remote recorder at the USGS gage immediately downstream of Barre Falls at Barre, transmits river stages directly to the dam. This gage is equipped with a digital-type water stage recorder and is operated and maintained under a cooperative stream gaging program with the USGS and hence provides a continuous official record of releases from the project. It is essential that this gage be checked frequently to assure proper operation. If inspection indicates a need for repair, the USGS should be notified immediately and arrangements made to have the equipment repaired.

43. TELEPHONE TRANSMITTER (TELEMARK)

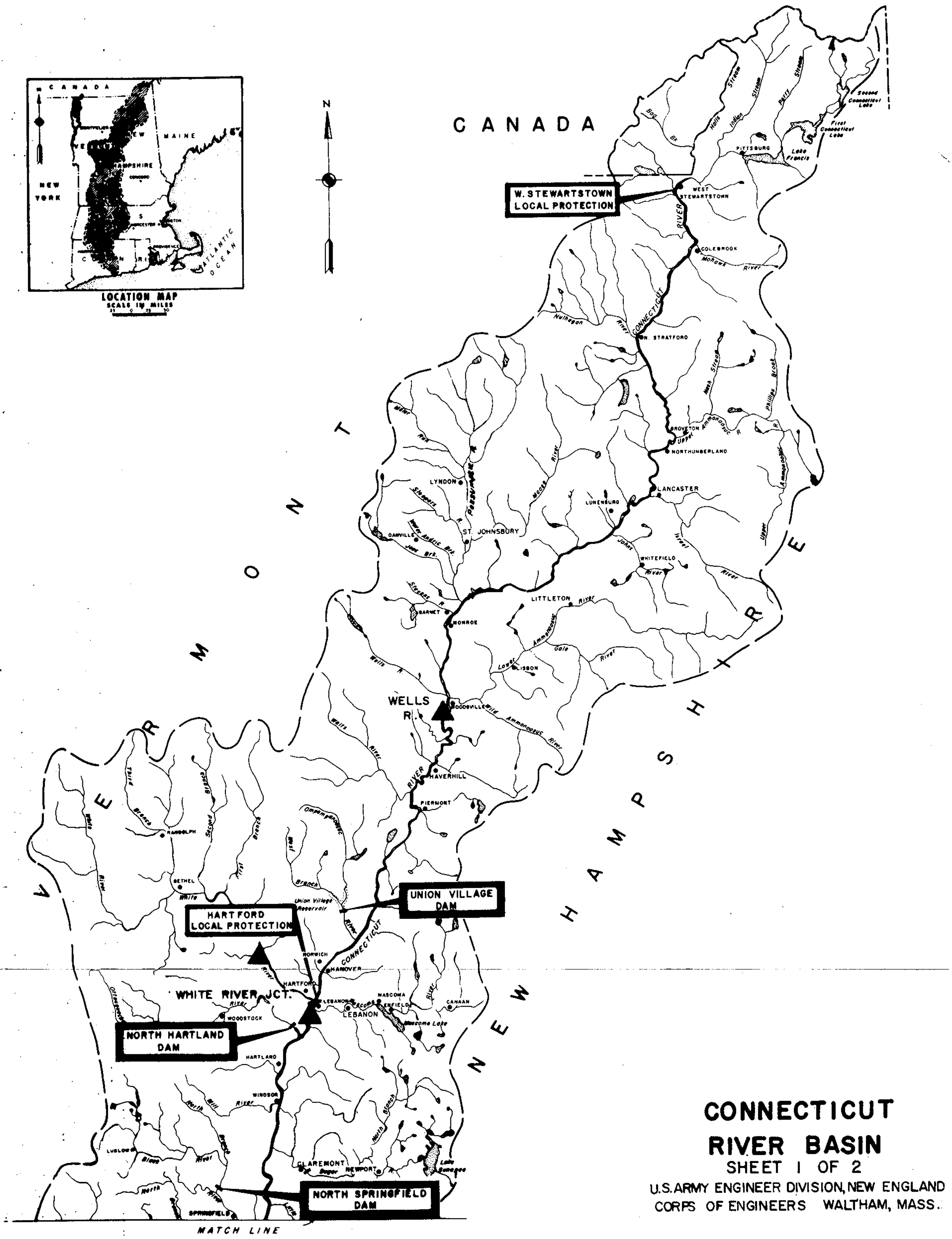
The telephone transmitter on the Chicopee River at Indian Orchard is used for regulation in the Chicopee River watershed. The project manager of Barre Falls calls the gage at Indian Orchard as part of the normal weekly report. During failure of communications, the Barre Falls project manager should also consider stages at the Indian Orchard gage. Should the telemark become inoperable during the weekly check, the project manager should visit the gage. If the trouble cannot be determined the telephone company should be requested to check their circuits in the presence of the project manager. If the telemark still is not functioning by this time, the USGS should be notified. Batteries for equipment at these gaging stations will be furnished and installed by the USGS.

44. SNOW SAMPLING SET

A snow sampling set has been assigned to the project manager at Barre Falls Snow surveys in the Chicopee River watershed will be carried out by the project managers and their assistants from Barre Falls and East Brimfield Lake. Procedures for obtaining snow survey data should follow instructions set forth in "Snow Sampling Guide, Department of Agriculture, Handbook 1960". If given proper care, the only maintenance required would be occasional replacement of worn out cutterheads.

Snow surveys will normally be conducted from 15 January to 15 April or as long as RCC considers necessary. Prior preparation by the project manager should include inspection of the snow survey equipment and reconnaissance of the snow survey courses.

Full snow surveys will generally take place every other week to coincide with surveys by the Massachusetts Water Resources Commission, New Hampshire Water Resources Board and the New England Power Company. On alternate weeks, index snow surveys involving selected snow courses will be taken, to determine general conditions in the watershed.




# CONNECTICUT RIVER BASIN

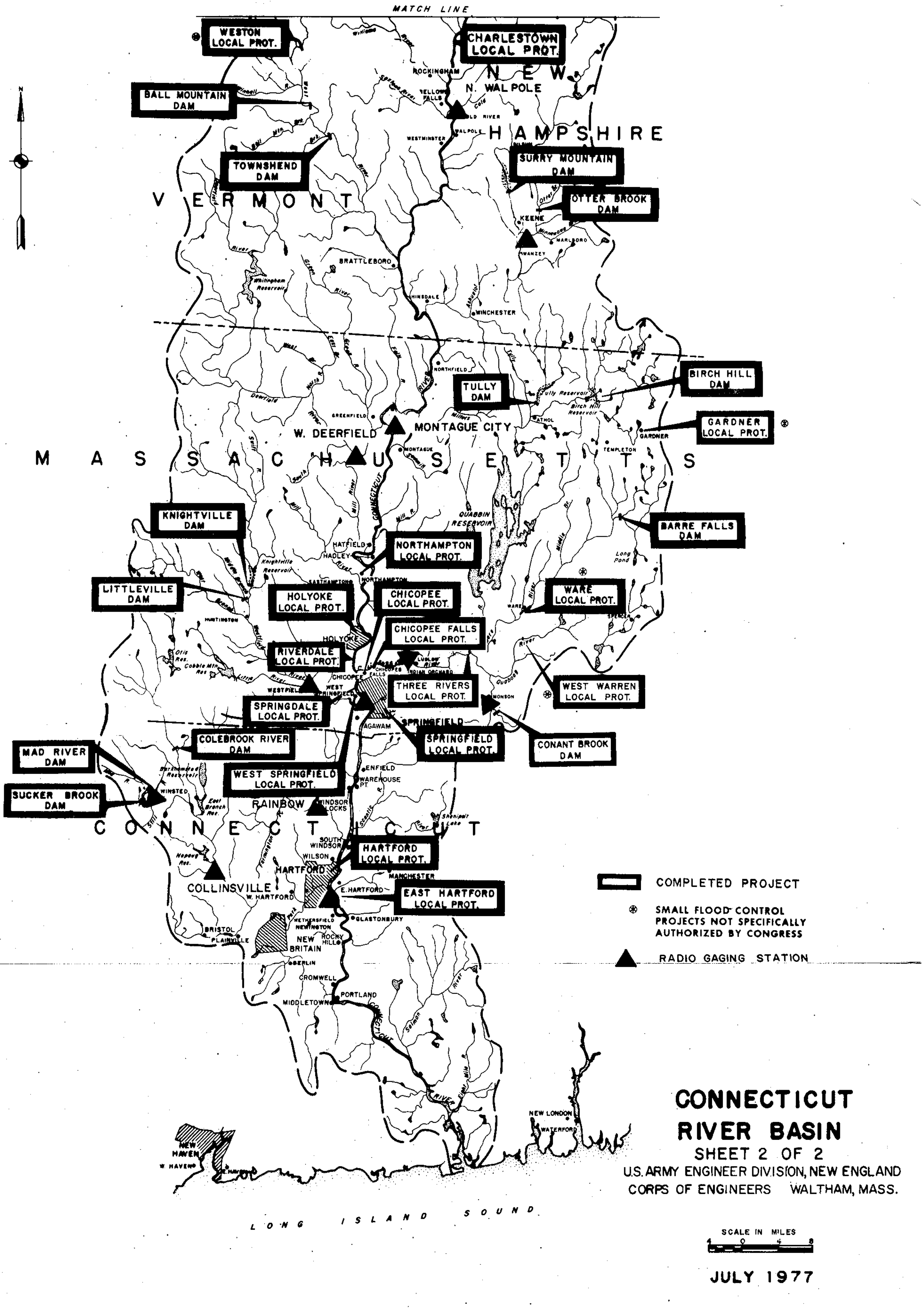
SHEET 1 OF 2

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

SCALE IN MILES
4 0 4 8

JULY 1977

PLATE G-1




# CONNECTICUT RIVER BASIN

SHEET 2 OF 2

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

JULY 1977

PLATE G-2

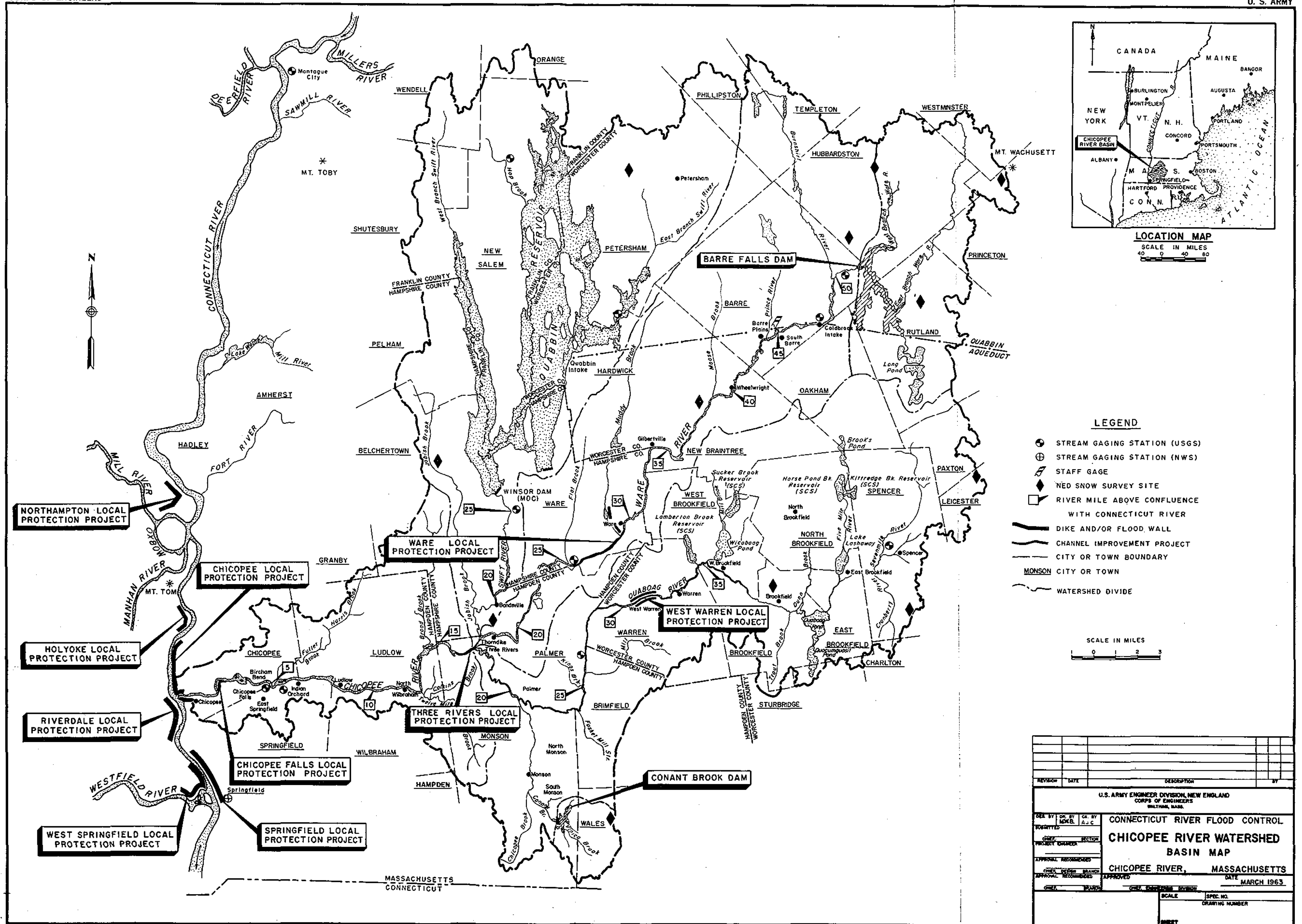
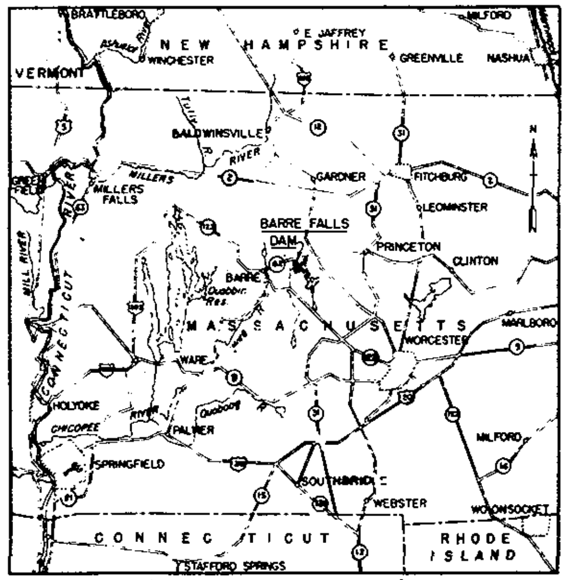
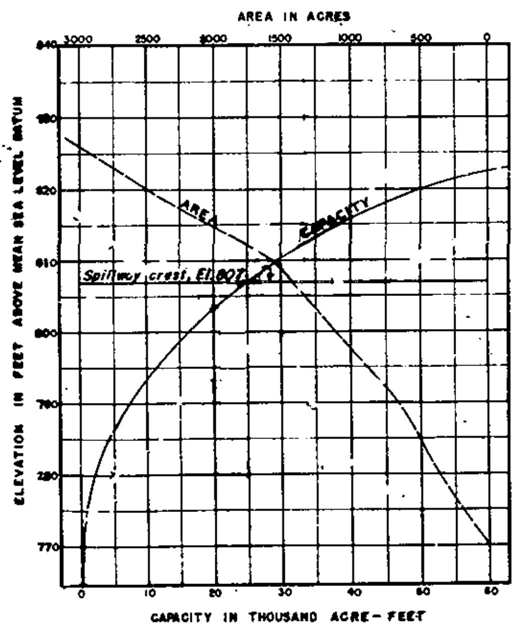

LOCATION MAP
SCALE IN MILES
CANADA
MAINE
NEW YORK
VT.
N. H.
MASS.
CONN.
R.I.
ATLANTIC OCEAN
CHICOPEE RIVER BASIN
LEGEND
STREAM GAGING STATION (USGS)
STREAM GAGING STATION (NWS)
STAFF GAGE
NED SNOW SURVEY SITE
RIVER MILE ABOVE CONFLUENCE WITH CONNECTICUT RIVER
DIKE AND/OR FLOOD WALL
CHANNEL IMPROVEMENT PROJECT
CITY OR TOWN BOUNDARY
MONSON CITY OR TOWN
WATERSHED DIVIDE
SCALE IN MILES
NORTHAMPTON LOCAL PROTECTION PROJECT
CHICOPEE LOCAL PROTECTION PROJECT
HOLYOKE LOCAL PROTECTION PROJECT
RIVERDALE LOCAL PROTECTION PROJECT
CHICOPEE FALLS LOCAL PROTECTION PROJECT
WEST SPRINGFIELD LOCAL PROTECTION PROJECT
SPRINGFIELD LOCAL PROTECTION PROJECT
THREE RIVERS LOCAL PROTECTION PROJECT
WARE LOCAL PROTECTION PROJECT
WEST WARREN LOCAL PROTECTION PROJECT
BARRE FALLS DAM
CONANT BROOK DAM
QUABBIN RESERVOIR
QUABBIN AQUEDUCT
WINSOR DAM (MDC)
CONNECTICUT RIVER
WESTFIELD RIVER
CHICOPEE RIVER
WARE RIVER
SWIFT RIVER
QUABOAG RIVER
MILLERS RIVER
DEERFIELD RIVER
MASSACHUSETTS
CONNECTICUT
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER WATERSHED
BASIN MAP
CHICOPEE RIVER, MASSACHUSETTS
MARCH 1963

PLATE G-3




VICINITY MAP

SCALE: 1 IN. = 8 MI.

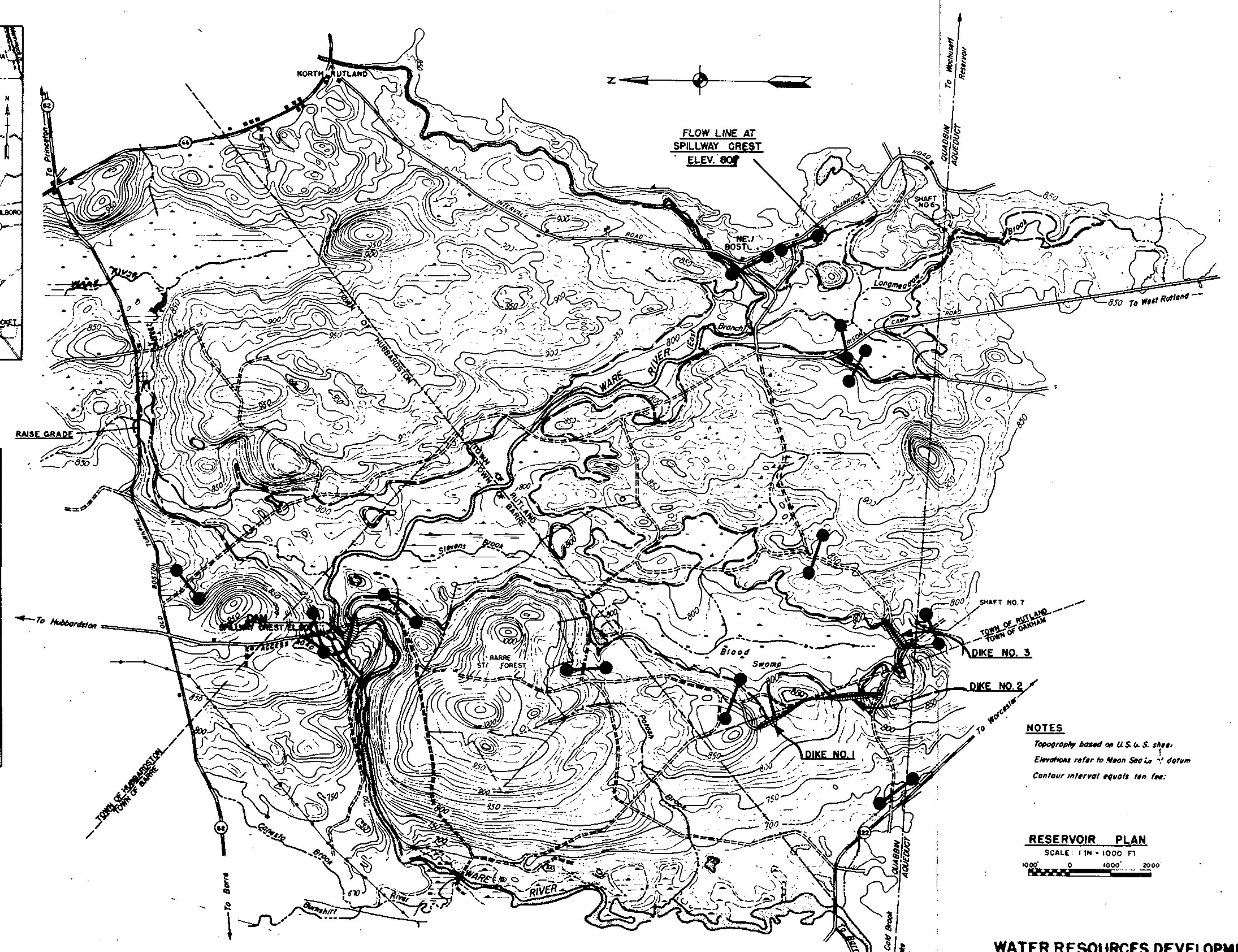



AREA AND CAPACITY CURVES

DRAINAGE AREA 57 SQ. MI.

LEGEND

Existing numbered routes
Existing paved highways
Existing gravel roads
Proposed highway relocation or improvement
Reservoir flowage area at spillway crest El. 807
Road Barricade




NOTES

Topography based on U.S.G.S. sheet
Elevations refer to Mean Sea Level datum
Contour interval equals ten feet

RESERVOIR PLAN

SCALE: 1 IN. = 1000 FT.

1000 0 1000 2000

WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN

BARRE FALLS DAM

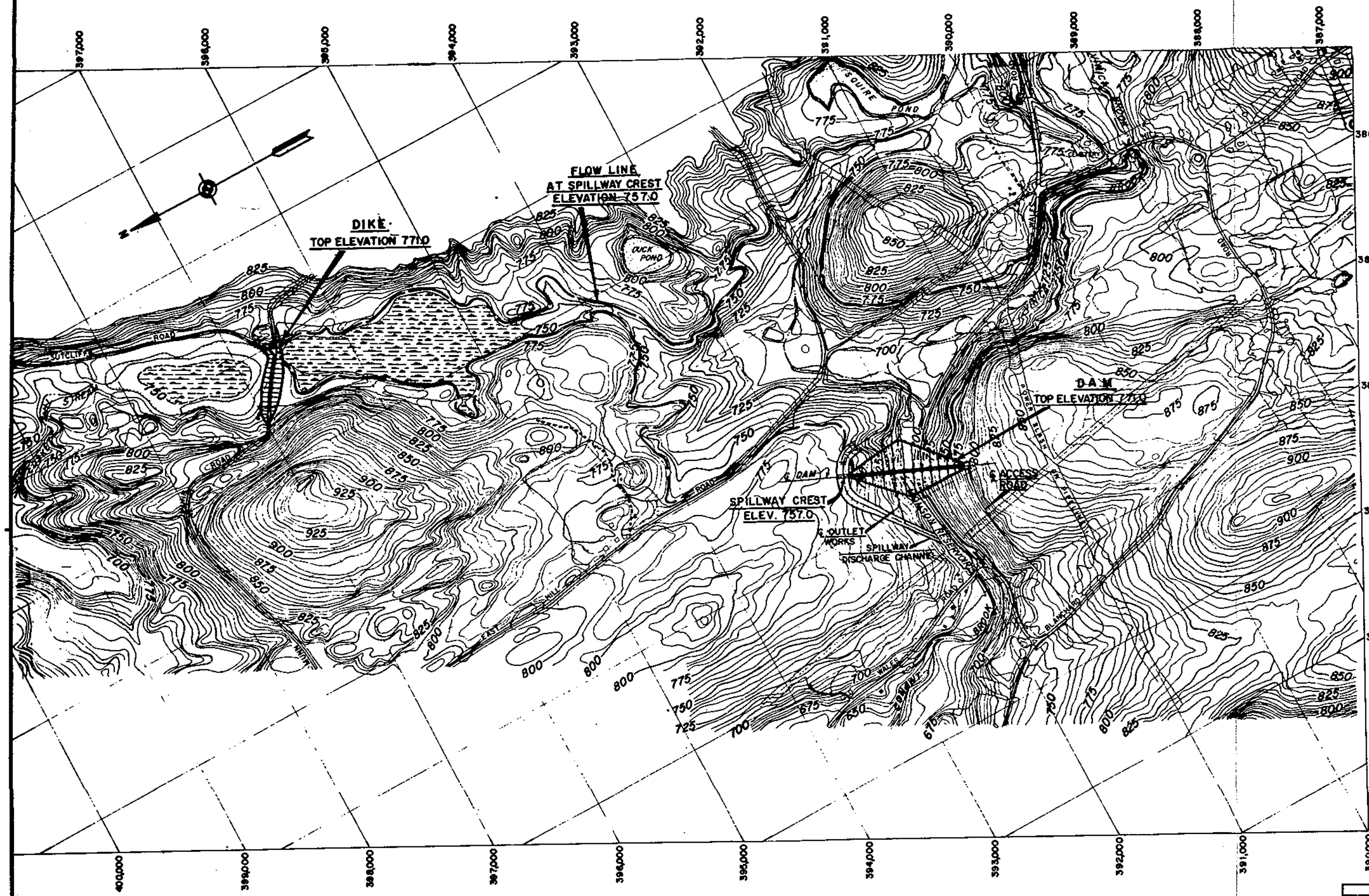
# RESERVOIR MAP

NEW ENGLAND DIVISION, WALTHAM, MA.
AUGUST 1978

PLATE G-4

CORPS OF ENGINEERS

U.S. ARMY




NOTES:
*Elevations refer to Mean Sea Level.*

## RESERVOIR PLAN

SCALE IN FEET
400' 0 400' 800'

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN

**CONANT BROOK DAM**
**RESERVOIR MAP**

CHICOPEE RIVER, MASSACHUSETTS

DATE MARCH 1963

SCALE 1"=400'

PLATE G-5

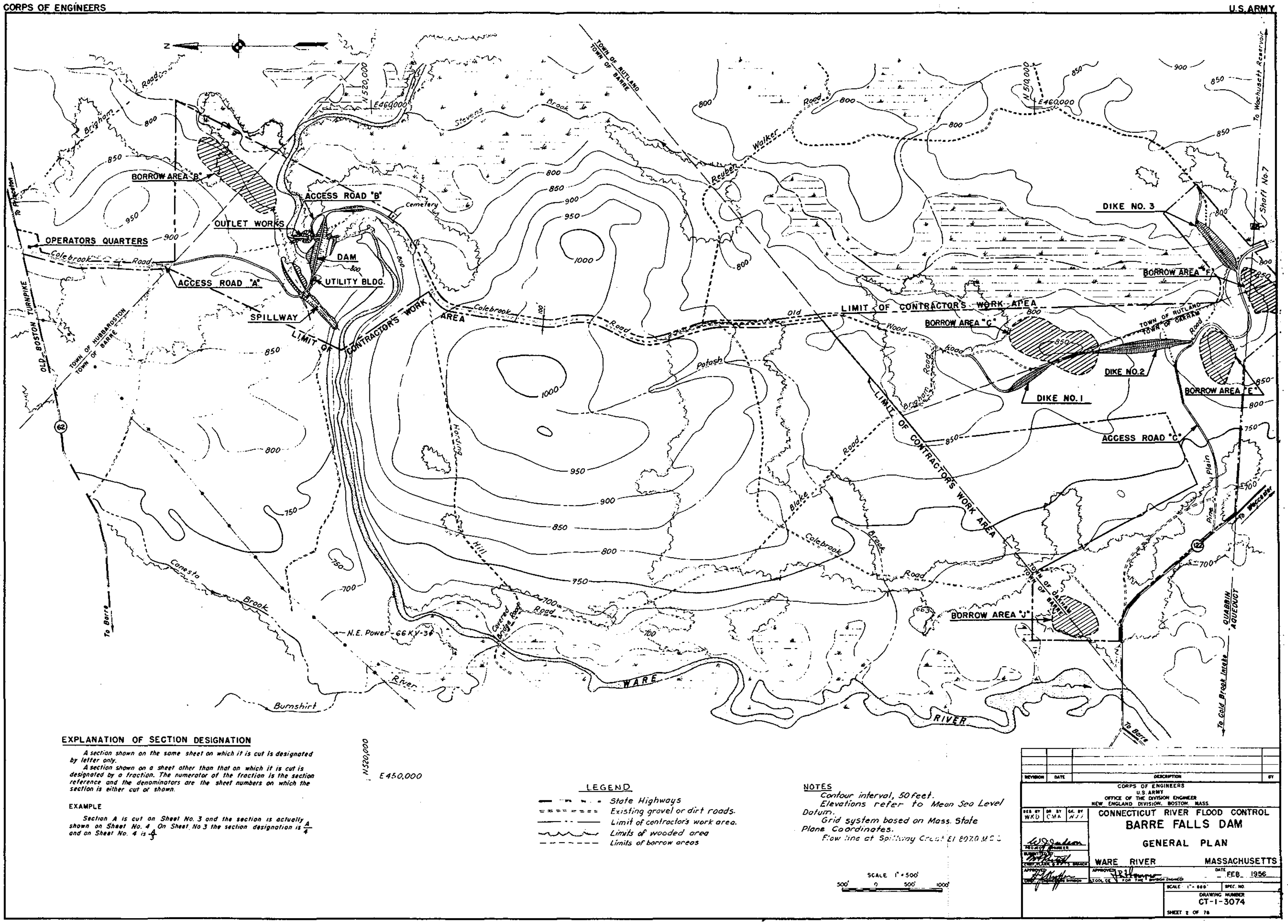
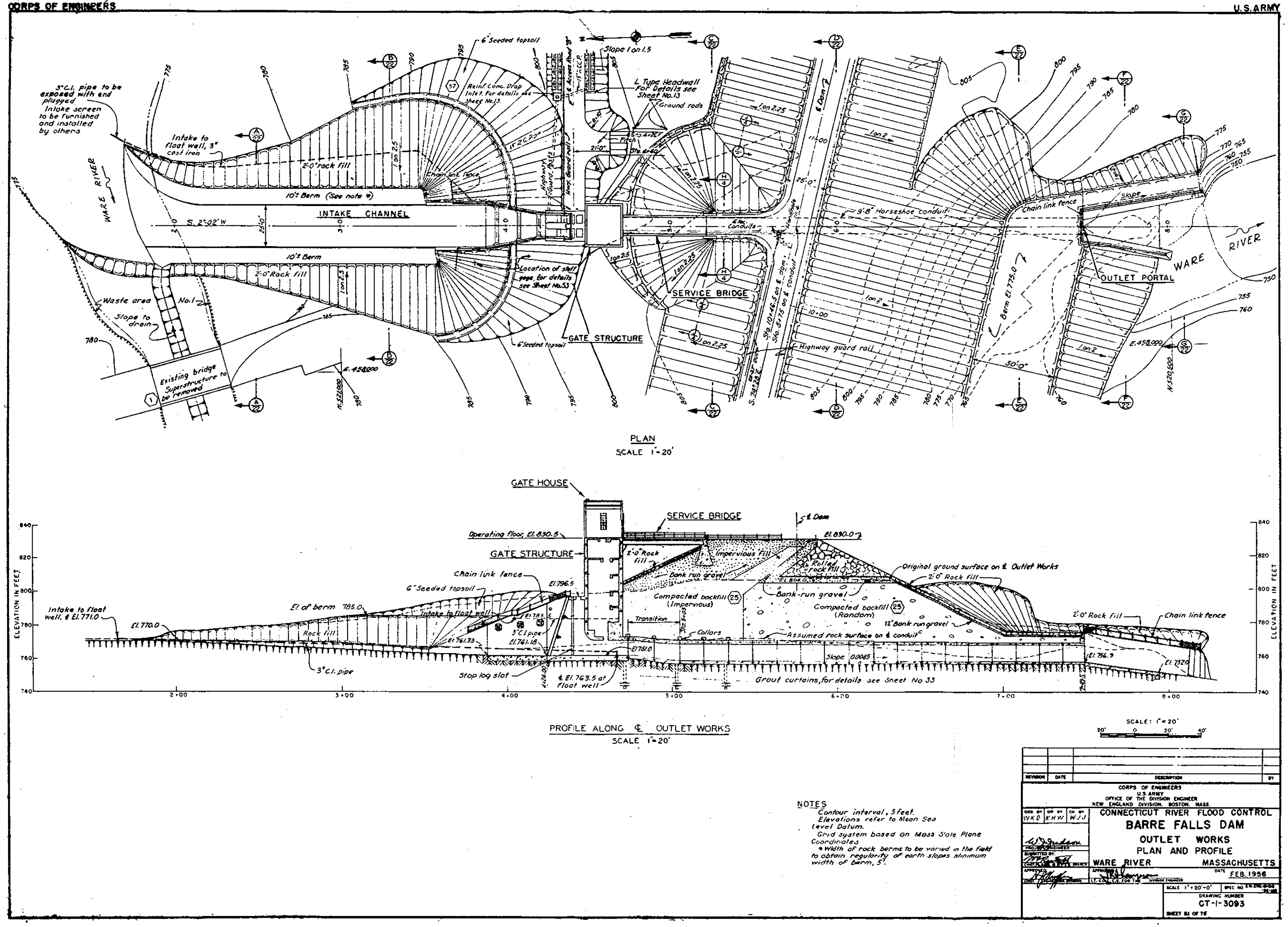

BORROW AREA "B"
ACCESS ROAD "B"
OUTLET WORKS
OPERATORS QUARTERS
DAM
UTILITY BLDG.
ACCESS ROAD "A"
SPILLWAY
LIMIT OF CONTRACTOR'S WORK AREA
DIKE NO. 3
BORROW AREA "F"
BORROW AREA "C"
DIKE NO. 2
DIKE NO. 1
BORROW AREA "E"
ACCESS ROAD "C"
BORROW AREA "J"
TOWN OF RUTLAND
TOWN OF BARRE
TOWN OF HUBBARDSTON
TOWN OF OAKHAM
OLD BOSTON TURNPIKE
Colebrook Road
Stevens Brook
Reuben Walker Road
Potash Road
Old Wood Road
Brigham Road
Blake Road
Colebrook Road
Pine Plain Road
Canesta Brook
Burnshirt River
WARE RIVER
Covered Bridge Road
N.E. Power 66 KV
Cemetery
To Princeton
To Barre
To Wachusett Reservoir
Shaft No. 7
To Worcester
QUABBIN AQUEDUCT
To Cold Brook Intake
N520,000
E460,000
N510,000
E450,000
EXPLANATION OF SECTION DESIGNATION
A section shown on the same sheet on which it is cut is designated by letter only.
A section shown on a sheet other than that on which it is cut is designated by a fraction. The numerator of the fraction is the section reference and the denominators are the sheet numbers on which the section is either cut or shown.
EXAMPLE
Section A is cut on Sheet No. 3 and the section is actually shown on Sheet No. 4. On Sheet No 3 the section designation is A/4 and on Sheet No. 4 is A/3
LEGEND
State Highways
Existing gravel or dirt roads.
Limit of contractor's work area.
Limits of wooded area
Limits of borrow areas
NOTES
Contour interval, 50 feet.
Elevations refer to Mean Sea Level Datum.
Grid system based on Mass. State Plane Coordinates.
SCALE 1" = 500'
REVISION
DATE
DESCRIPTION
BY
CORPS OF ENGINEERS
U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.
CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
GENERAL PLAN
WARE RIVER
MASSACHUSETTS
DATE FEB. 1956
DRAWING NUMBER
CT-1-3074
SHEET 2 OF 76

PLATE G-6




(REVISED 25 APRIL 1956)

PLATE G-7

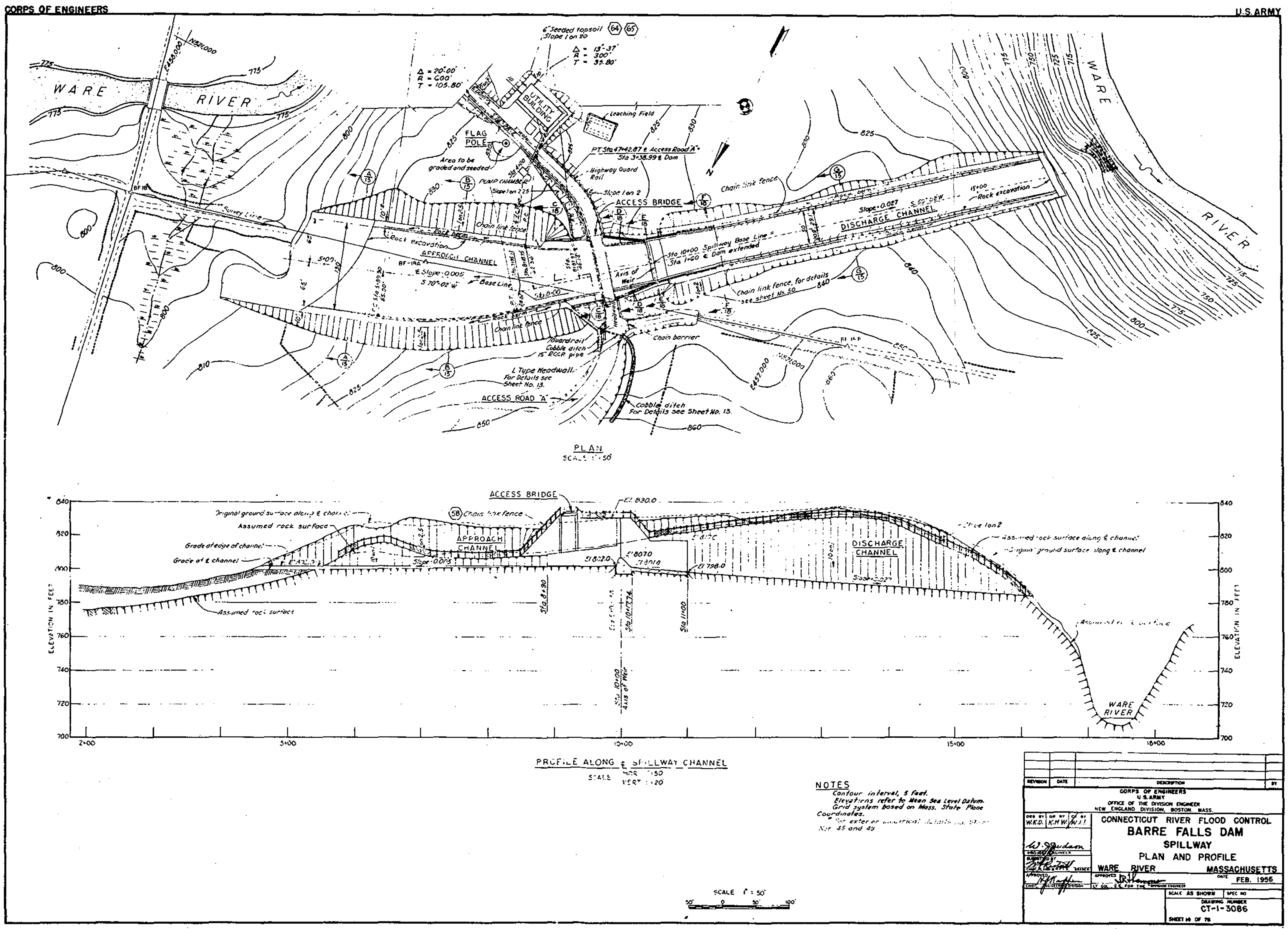

CORPS OF ENGINEERS
U.S. ARMY
WARE RIVER
UTILITY BUILDING
FLAG POLE
Leaching Field
PUMP CHAMBER
ACCESS BRIDGE
APPROACH CHANNEL
DISCHARGE CHANNEL
Chain link fence
Rock excavation
Axis of Weir
Chain barrier
ACCESS ROAD "A"
L Type Headwall. For Details see Sheet No. 13.
Cobble ditch For Details see Sheet No. 13.
Highway Guard Rail
PLAN
SCALE 1"=50'
PROFILE ALONG ℄ SPILLWAY CHANNEL
SCALE HOR. 1"=50 VERT. 1"=20
ELEVATION IN FEET
Original ground surface along ℄ channel
Assumed rock surface
Grade at edge of channel
Grade of ℄ channel
El. 830.0
Sta 10+00 Axis of Weir
NOTES
Contour interval, 5 feet.
Elevations refer to Mean Sea Level Datum.
Grid system based on Mass. State Plane Coordinates.
SCALE 1" = 50'
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.
CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
SPILLWAY
PLAN AND PROFILE
WARE RIVER
MASSACHUSETTS
FEB. 1956
SCALE AS SHOWN
CT-1-3086

PLATE G-8

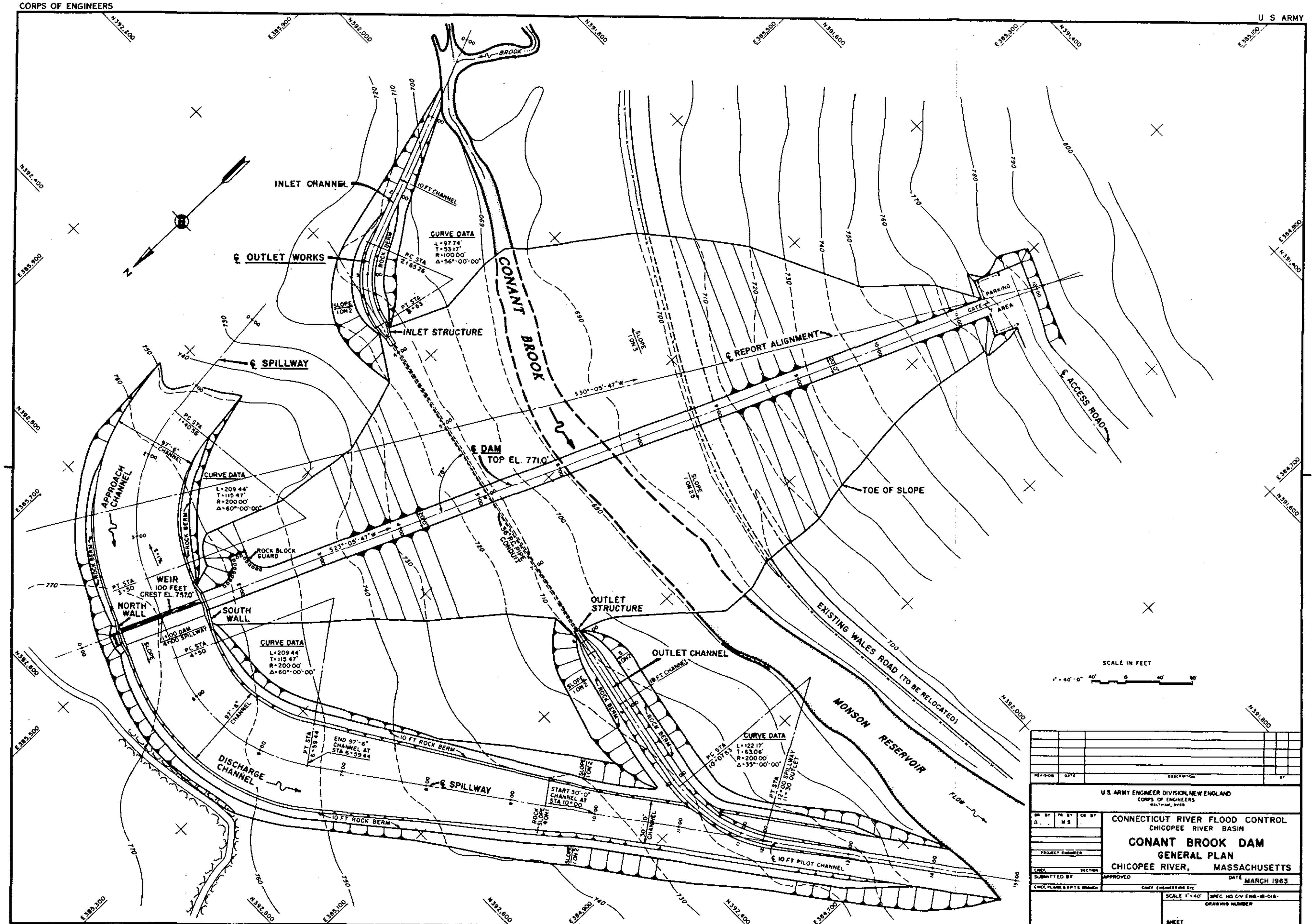

CORPS OF ENGINEERS
U. S. ARMY
INLET CHANNEL
℄ OUTLET WORKS
INLET STRUCTURE
℄ SPILLWAY
APPROACH CHANNEL
℄ DAM
TOP EL. 771.0'
CONANT BROOK
℄ REPORT ALIGNMENT
PARKING AREA
℄ ACCESS ROAD
TOE OF SLOPE
WEIR
100 FEET
CREST EL. 757.0'
NORTH WALL
SOUTH WALL
ROCK BLOCK GUARD
OUTLET STRUCTURE
OUTLET CHANNEL
DISCHARGE CHANNEL
EXISTING WALES ROAD (TO BE RELOCATED)
MONSON RESERVOIR
FLOW
SCALE IN FEET
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN
CONANT BROOK DAM
GENERAL PLAN
CHICOPEE RIVER, MASSACHUSETTS
MARCH 1963

PLATE G-9

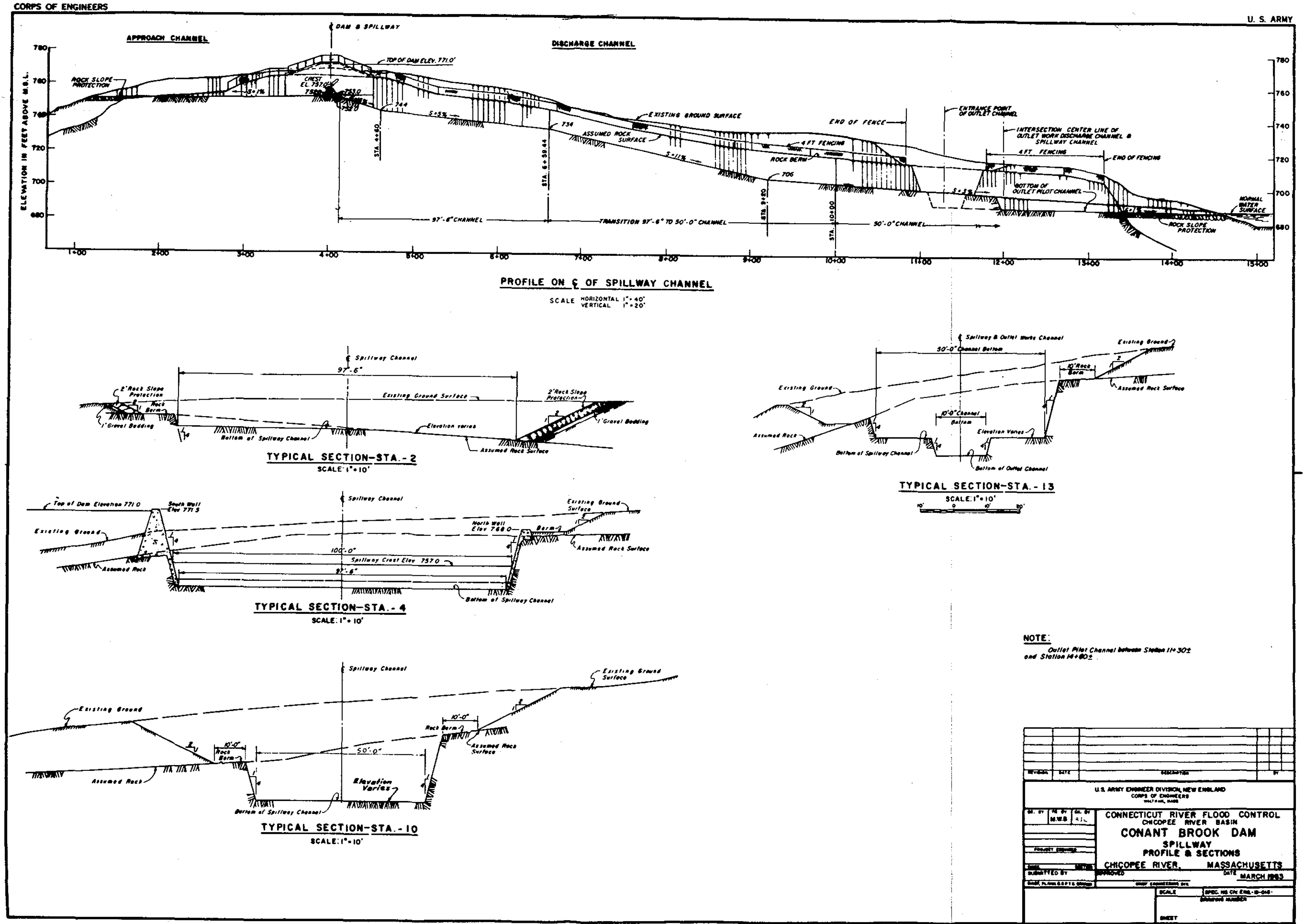
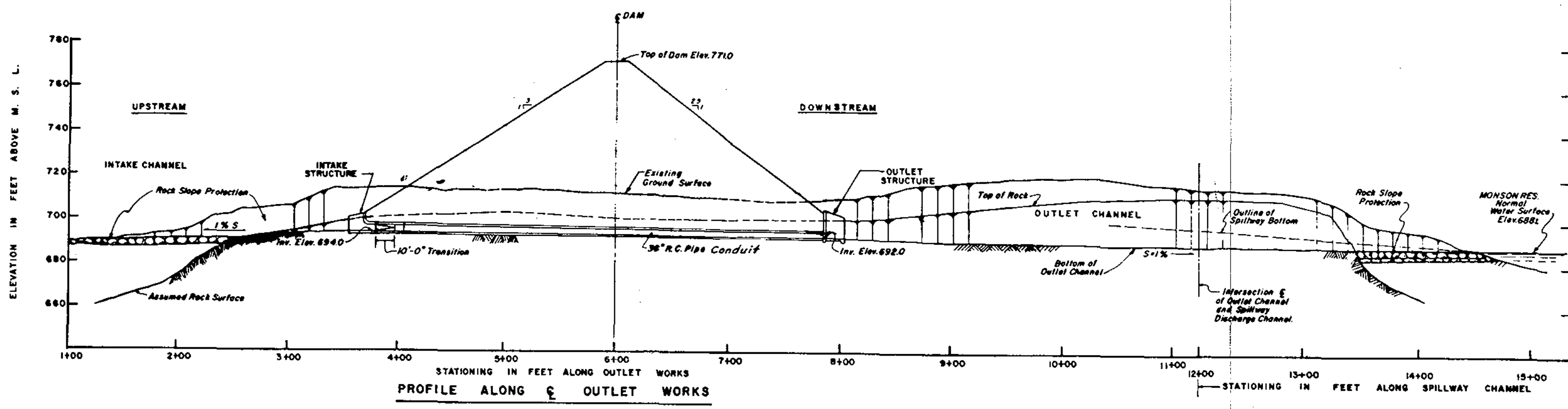

CORPS OF ENGINEERS
U. S. ARMY
APPROACH CHANNEL
DAM & SPILLWAY
DISCHARGE CHANNEL
TOP OF DAM ELEV. 771.0'
ROCK SLOPE PROTECTION
CREST EL 757.0
EXISTING GROUND SURFACE
ASSUMED ROCK SURFACE
END OF FENCE
ENTRANCE POINT OF OUTLET CHANNEL
INTERSECTION CENTER LINE OF OUTLET WORK DISCHARGE CHANNEL & SPILLWAY CHANNEL
4 FT. FENCING
END OF FENCING
ROCK BERM
BOTTOM OF OUTLET PILOT CHANNEL
NORMAL WATER SURFACE
ELEVATION IN FEET ABOVE M.S.L.
97'-6" CHANNEL
TRANSITION 97'-6" TO 50'-0" CHANNEL
50'-0" CHANNEL
PROFILE ON ℄ OF SPILLWAY CHANNEL
SCALE HORIZONTAL 1" = 40' VERTICAL 1" = 20'
TYPICAL SECTION-STA.-2
SCALE: 1" = 10'
TYPICAL SECTION-STA.-4
SCALE: 1" = 10'
TYPICAL SECTION-STA.-10
SCALE: 1" = 10'
TYPICAL SECTION-STA.-13
SCALE: 1" = 10'
NOTE:
Outlet Pilot Channel between Station 11+30± and Station 14+80±.
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN
CONANT BROOK DAM
SPILLWAY
PROFILE & SECTIONS
CHICOPEE RIVER, MASSACHUSETTS
MARCH 1963

PLATE G-10

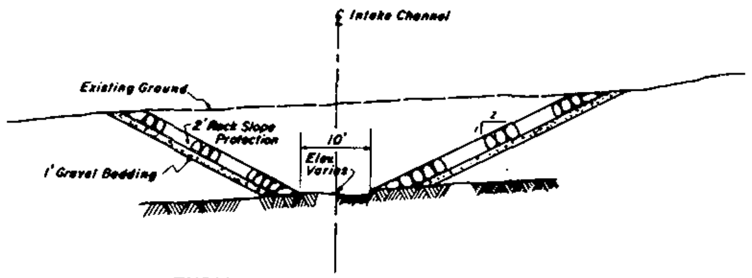
CORPS OF ENGINEERS

U. S. ARMY



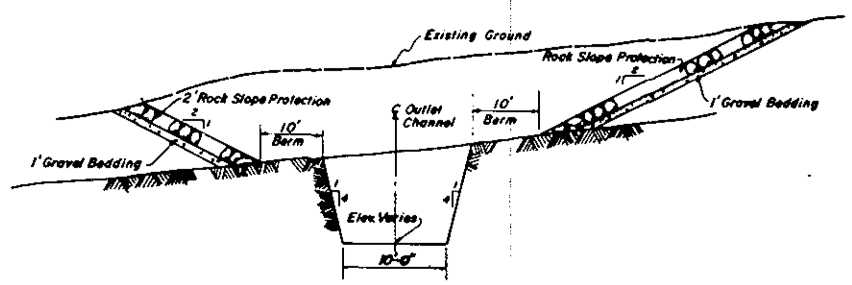

PROFILE ALONG ℄ OUTLET WORKS

SCALE: HORIZONTAL 1" = 40'
VERTICAL 1" = 20'




TYPICAL SECTION INTAKE CHANNEL

NOT TO SCALE




TYPICAL SECTION OUTLET CHANNEL

NOT TO SCALE

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DR. BY | TR. BY MWB | CK. BY

PROJECT ENGINEER

CHIEF, SECTION

SUBMITTED BY

CHIEF, PLANNING & RPTS BRANCH

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN

**CONANT BROOK DAM**

OUTLET WORKS
PROFILE & SECTIONS

CHICOPEE RIVER, MASSACHUSETTS

APPROVED

CHIEF, ENGINEERING DIV.

DATE MARCH 1963

SCALE

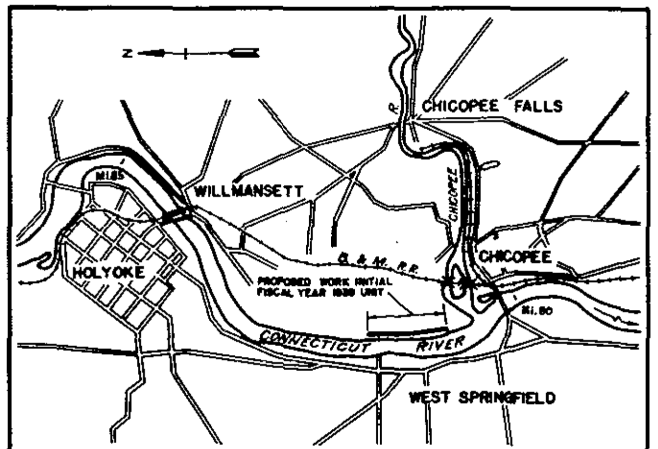
SPEC. NO. CIV-

DRAWING NUMBER

SHEET

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY.

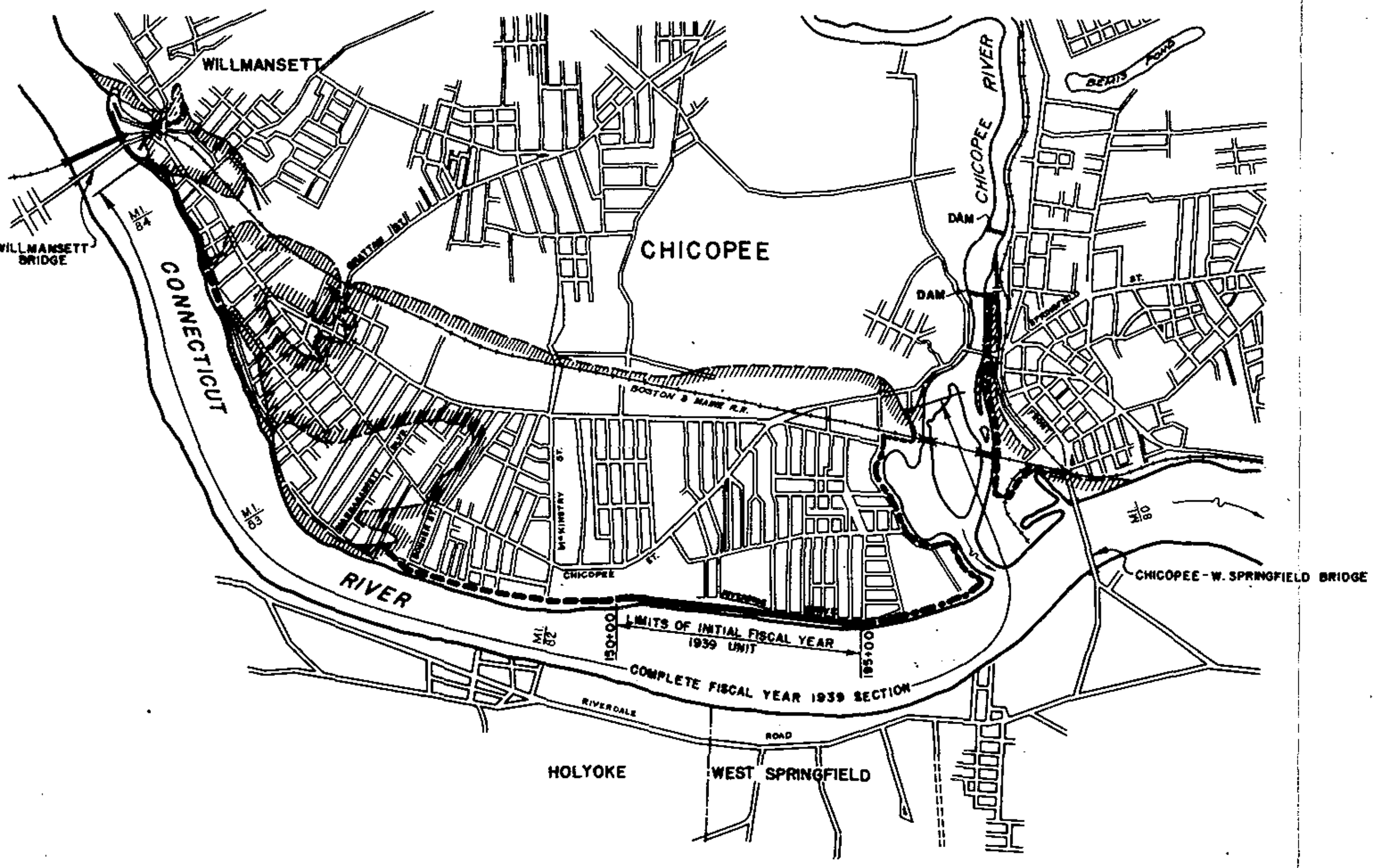



VICINITY MAP

SCALE 1 IN = 1 MI.

## INDEX TO DRAWINGS

| SHEET NO. | DESCRIPTION | FILE NUMBER |
|---|---|---|
| 1. | PROJECT LOCATION AND INDEX | CT-4-1122 |
| 2. | SUBSURFACE EXPLORATION | CT-2-1106 |
| 3. | BORROW AREAS | CT-2-1111 |
| 4. | GENERAL PLAN (Sta. 0+00 to 21+20) | CT-4-1121 |
| 5. | GENERAL PLAN (Sta. 21+20 to 44+87.57±) | CT-4-1120 |
| 6. | EMBANKMENT DETAILS | CT-4-1137 |
| 7. | TOE DRAIN PROFILE AND SECTIONS | CT-4-1311 |




## LEGEND

Project

Present Dike

Future Construction

Overflow Limits of the March 1936 Flood

RECORD DRAWINGS

| | | | | |
|---|---|---|---|---|
| 3-3-39 | ADDED SHEET NO. 7 TO SET | P.C.H. | M.S. | J.S.B. |
| DATE | REVISION | REV. BY | CK. BY | AP. BY |

CONNECTICUT RIVER FLOOD CONTROL

**CHICOPEE DIKE**

INITIAL FISCAL YEAR 1939 UNIT

**PROJECT LOCATION AND INDEX**

CHICOPEE, MASS.

CONNECTICUT RIVER MASSACHUSETTS

IN 7 SHEETS SCALE 1 IN.=1200 FT. SHEET NO. 1

1200' 0 1200' 2400'

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., OCT. 1938

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIVISION
APPROVED: DISTRICT ENGINEER

DESIGNED: P.C. Hancomb, ASST. ENGINEER

DRAWN BY:
TRACED BY: M.R.
CHECKED BY: P.C.H.

FILE NO. CT-4-1122
TO ACCOMPANY
DATED OCT. 29, 1938

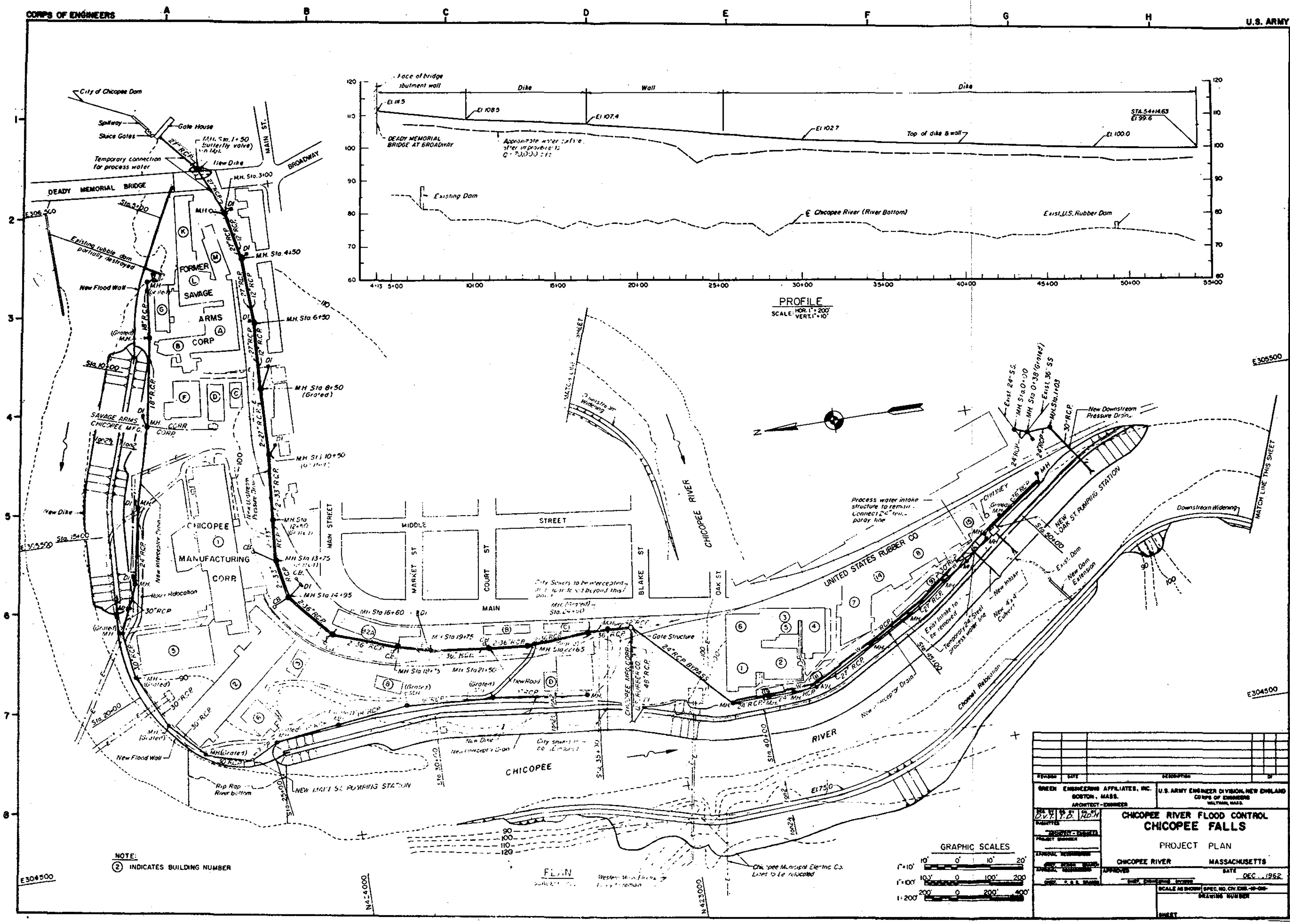
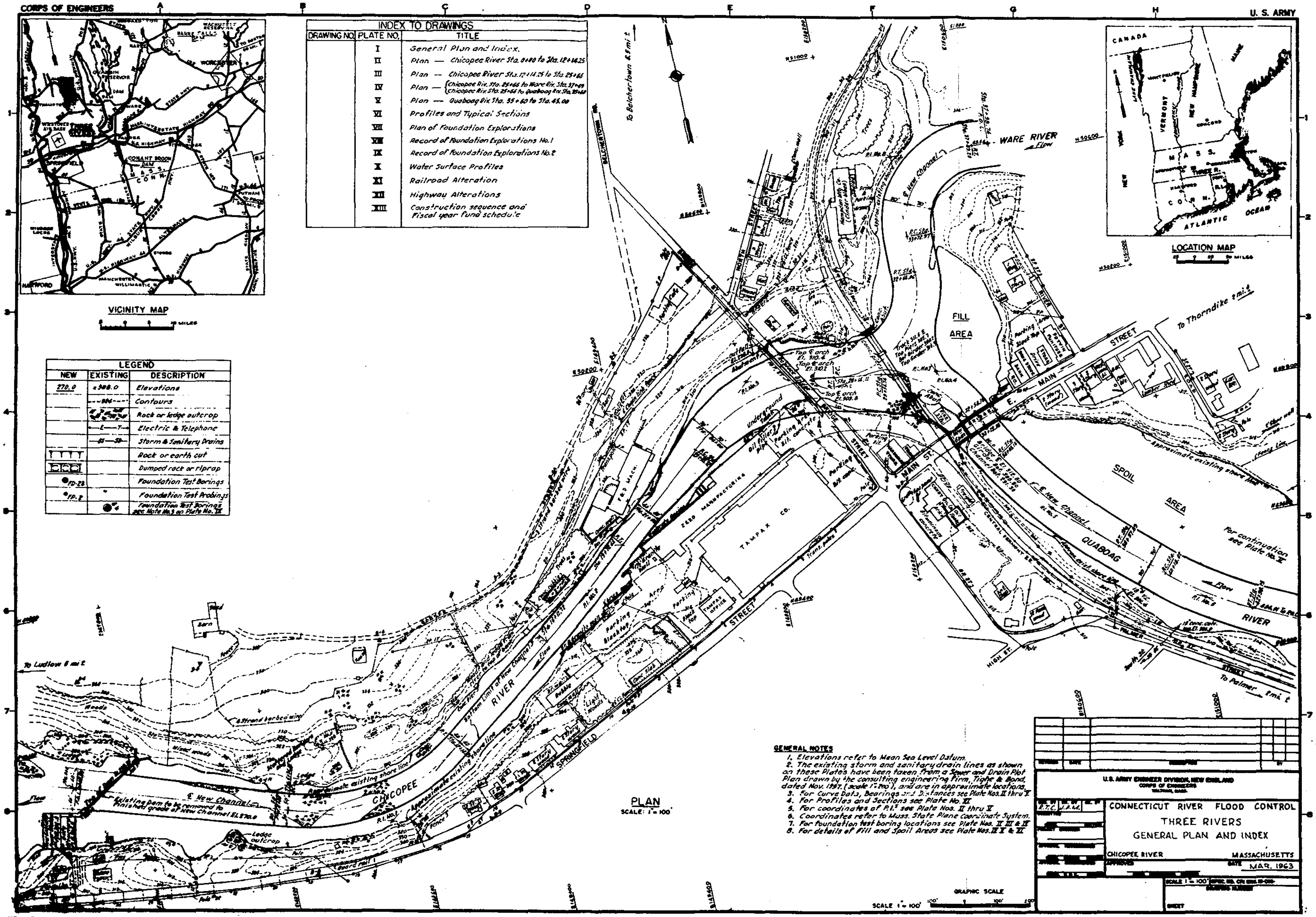

CORPS OF ENGINEERS
U.S. ARMY
PROFILE
SCALE: HOR. 1" = 200' VERT. 1" = 10'
Face of bridge abutment wall
Dike
Wall
Dike
DEADY MEMORIAL BRIDGE AT BROADWAY
Top of dike & wall
Existing Dam
Chicopee River (River Bottom)
Exist. U.S. Rubber Dam
City of Chicopee Dam
Spillway
Sluice Gates
Gate House
New Dike
Temporary connection for process water
DEADY MEMORIAL BRIDGE
MAIN ST.
BROADWAY
Existing rubble dam partially destroyed
New Flood Wall
FORMER SAVAGE ARMS CORP
SAVAGE ARMS CHICOPEE MFG. CORP.
CHICOPEE MANUFACTURING CORP.
New Dike
MIDDLE
STREET
MAIN STREET
MARKET ST
COURT ST
BLAKE ST
OAK ST
MAIN
CHICOPEE RIVER
UNITED STATES RUBBER CO
NEW LOAK ST. PUMPING STATION
Downstream Widening
MATCH LINE THIS SHEET
Gate Structure
24" RCP BYPASS
CHICOPEE MFG. CORP.
RIVER
CHICOPEE
NEW MAIN ST. PUMPING STATION
Rip Rap River bottom
New Flood Wall
Channel Relocation
NOTE:
(2) INDICATES BUILDING NUMBER
PLAN
GRAPHIC SCALES
GREEN ENGINEERING AFFILIATES, INC. BOSTON, MASS. ARCHITECT-ENGINEER
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
PROJECT PLAN
CHICOPEE RIVER
MASSACHUSETTS
DEC., 1962

PLATE G-13




| INDEX TO DRAWINGS | | |
|---|---|---|
| DRAWING NO. | PLATE NO. | TITLE |
| | I | General Plan and Index. |
| | II | Plan — Chicopee River Sta. 0+80 to Sta. 12+14.25 |
| | III | Plan — Chicopee River Sta. 12+14.25 to Sta. 25+65 |
| | IV | Plan — Chicopee Riv. Sta. 25+65 to Ware Riv. Sta. 37+69; Chicopee Riv. Sta. 25+65 to Quaboag Riv. Sta. 35+60 |
| | V | Plan — Quaboag Riv. Sta. 35+60 to Sta. 45.00 |
| | VI | Profiles and Typical Sections |
| | VII | Plan of Foundation Explorations |
| | VIII | Record of Foundation Explorations No. 1 |
| | IX | Record of Foundation Explorations No. 2 |
| | X | Water Surface Profiles |
| | XI | Railroad Alteration |
| | XII | Highway Alterations |
| | XIII | Construction sequence and Fiscal year fund schedule |

| LEGEND | | |
|---|---|---|
| NEW | EXISTING | DESCRIPTION |
| 270.0 | ×308.0 | Elevations |
| | | Contours |
| | | Rock or ledge outcrop |
| | —E—T— | Electric & Telephone |
| | —SS—SD— | Storm & Sanitary Drains |
| | | Rock or earth cut |
| | | Dumped rock or riprap |
| FD-23 | | Foundation Test Borings |
| FD-2 | | Foundation Test Probings |
| | | Foundation Test Borings see Note No. 3 on Plate No. IX |

**GENERAL NOTES**

1. Elevations refer to Mean Sea Level Datum.
2. The existing storm and sanitary drain lines as shown on these Plates have been taken from a Sewer and Drain Plot Plan drawn by the consulting engineering firm, Tighe & Bond, dated Nov. 1957. (scale 1"=200'), and are in approximate locations.
3. For Curve Data, Bearings and Distances see Plate Nos. II thru V
4. For Profiles and Sections see Plate No. VI
5. For coordinates of P.I.$^s$ see Plate Nos. II thru V
6. Coordinates refer to Mass. State Plane Coordinate System.
7. For foundation test boring locations see Plate Nos. II III & IV
8. For details of Fill and Spoil Areas see Plate Nos. IV V & VI

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

R.T.C. | J.A.M.

CONNECTICUT RIVER FLOOD CONTROL
THREE RIVERS
GENERAL PLAN AND INDEX

CHICOPEE RIVER — MASSACHUSETTS

DATE MAR. 1963

SCALE 1" = 100'

SHEET

PLATE G-14

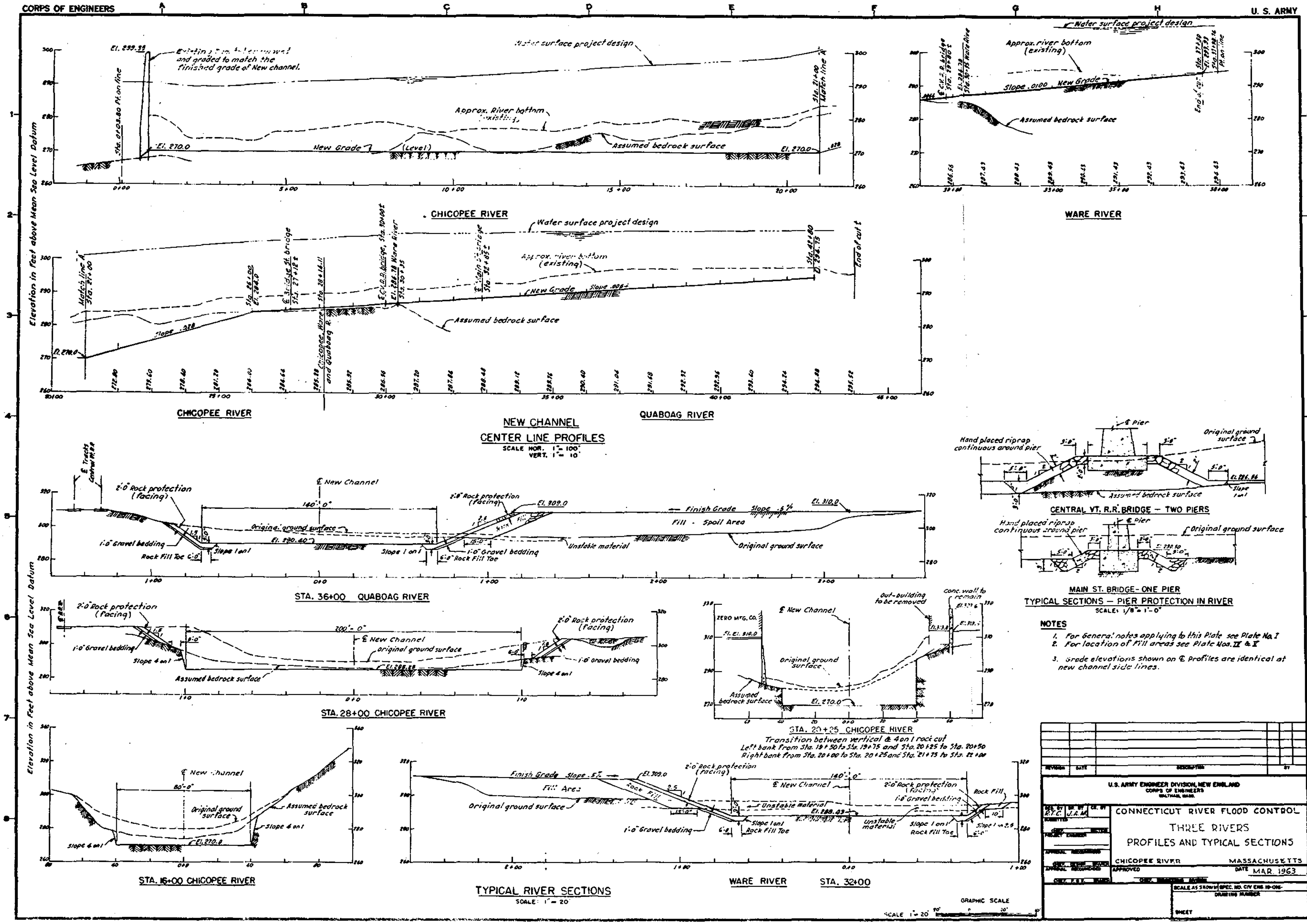

CORPS OF ENGINEERS
U. S. ARMY
CHICOPEE RIVER
Water surface project design
Approx. River bottom (existing)
New Grade
(Level)
Assumed bedrock surface
El. 270.0
and graded to match the finished grade of New channel.
WARE RIVER
Approx. river bottom (existing)
Slope .0100
New Grade
Assumed bedrock surface
Water surface project design
Approx. river bottom (existing)
Slope .028
Assumed bedrock surface
Elevation in Feet above Mean Sea Level Datum
CHICOPEE RIVER
QUABOAG RIVER
NEW CHANNEL
CENTER LINE PROFILES
SCALE HOR. 1" = 100'
VERT. 1" = 10'
2'-0" Rock protection (facing)
℄ New Channel
140'-0"
Finish Grade
Fill - Spoil Area
Original ground surface
1'-0" Gravel bedding
Rock Fill Toe
Slope 1 on 1
Unstable material
El. 309.0
El. 310.0
STA. 36+00 QUABOAG RIVER
200'-0"
Slope 4 on 1
Assumed bedrock surface
STA. 28+00 CHICOPEE RIVER
ZERO MFG. CO.
Out-building to be removed
Conc. wall to remain
Original ground surface
Assumed bedrock surface
El. 270.0
STA. 20+25 CHICOPEE RIVER
Transition between vertical & 4 on 1 rock cut
Left bank from Sta. 19+50 to Sta. 19+75 and Sta. 20+25 to Sta. 20+50
Right bank from Sta. 20+00 to Sta. 20+25 and Sta. 21+75 to Sta. 22+00
80'-0"
STA. 16+00 CHICOPEE RIVER
Fill Area
Rock Fill
WARE RIVER STA. 32+00
TYPICAL RIVER SECTIONS
SCALE: 1" = 20'
GRAPHIC SCALE
Hand placed riprap continuous around pier
℄ Pier
Original ground surface
CENTRAL VT. R.R. BRIDGE - TWO PIERS
MAIN ST. BRIDGE - ONE PIER
TYPICAL SECTIONS - PIER PROTECTION IN RIVER
SCALE: 1/8" = 1'-0"
NOTES
1. For General notes applying to this Plate see Plate No. I
2. For location of Fill areas see Plate Nos. IX & X
3. Grade elevations shown on ℄ Profiles are identical at new channel side lines.
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
CONNECTICUT RIVER FLOOD CONTROL
THREE RIVERS
PROFILES AND TYPICAL SECTIONS
CHICOPEE RIVER
MASSACHUSETTS
MAR. 1963

PLATE G-15

CORPS OF ENGINEERS

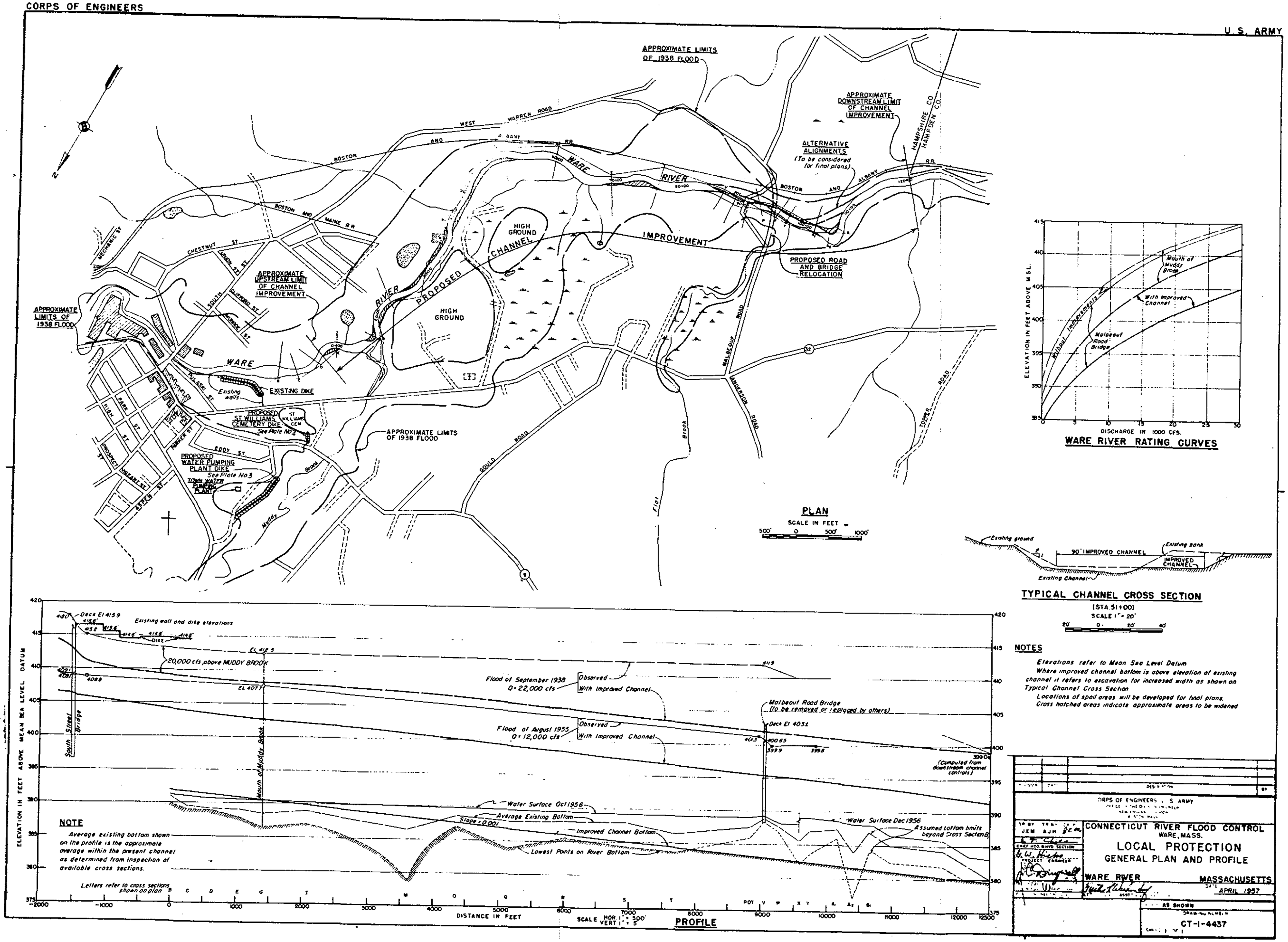
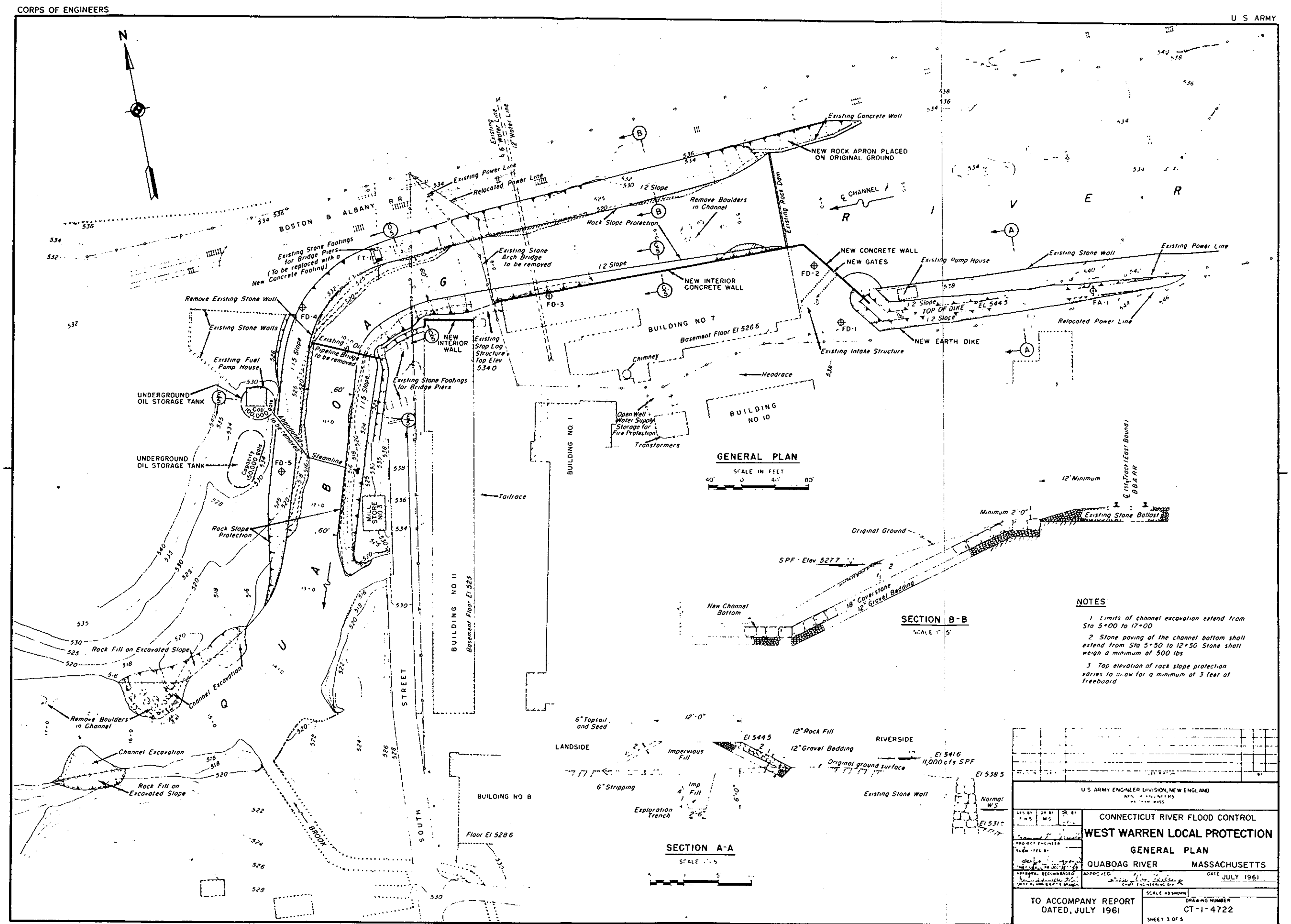



PLATE G-16



CORPS OF ENGINEERS
U S ARMY
N
BOSTON & ALBANY R R
Existing Power Line
Relocated Power Line
Existing 6" Water Line
12" Water Line
Existing Concrete Wall
NEW ROCK APRON PLACED ON ORIGINAL GROUND
CHANNEL
R I V E R
12 Slope
Remove Boulders in Channel
Rock Slope Protection
Existing Rock Dam
Existing Stone Footings for Bridge Piers (To be replaced with a New Concrete Footing)
Existing Stone Arch Bridge to be removed
NEW CONCRETE WALL
NEW GATES
Existing Pump House
Existing Stone Wall
Existing Power Line
NEW INTERIOR CONCRETE WALL
TOP OF DIKE EL 544 5
Relocated Power Line
NEW EARTH DIKE
Existing Intake Structure
BUILDING NO 7
Basement Floor El 526 6
Chimney
Headrace
Remove Existing Stone Wall
Existing Stone Walls
Existing Oil Pipeline Bridge to be removed
NEW INTERIOR WALL
Existing Stop Log Structure Top Elev 534 0
Existing Stone Footings for Bridge Piers
Existing Fuel Pump House
UNDERGROUND OIL STORAGE TANK
Abandoned to be removed
Steamline
Open Well Water Supply Storage for Fire Protection
Transformers
BUILDING NO 10
BUILDING NO 1
GENERAL PLAN
SCALE IN FEET
MILL STORE NO 3
Tailrace
Rock Slope Protection
Q U A B O A G
BUILDING NO 11
Basement Floor El 523
SOUTH STREET
Rock Fill on Excavated Slope
Channel Excavation
Remove Boulders in Channel
Rock Fill on Excavated Slope
BROOK
BUILDING NO 8
Floor El 528 6
12' Minimum
Exist Track (East Bound) B & A RR
Minimum 2'-0"
Existing Stone Ballast
Original Ground
SPF Elev 527 7
18" Coverstone
12" Gravel Bedding
New Channel Bottom
SECTION B-B
NOTES
1 Limits of channel excavation extend from Sta 5+00 to 17+00
2 Stone paving of the channel bottom shall extend from Sta 5+50 to 12+50 Stone shall weigh a minimum of 500 lbs
3 Top elevation of rock slope protection varies to allow for a minimum of 3 feet of freeboard
6" Topsoil and Seed
LANDSIDE
El 544 5
12" Rock Fill
12" Gravel Bedding
RIVERSIDE
Impervious Fill
El 541 6
11,000 cfs SPF
Original ground surface
6" Stripping
Imp Fill
Exploration Trench
Existing Stone Wall
El 538 5
Normal W S
SECTION A-A
U S ARMY ENGINEER DIVISION, NEW ENGLAND
CONNECTICUT RIVER FLOOD CONTROL
WEST WARREN LOCAL PROTECTION
GENERAL PLAN
QUABOAG RIVER MASSACHUSETTS
PROJECT ENGINEER
APPROVED
DATE JULY 1961
TO ACCOMPANY REPORT DATED, JULY 1961
SCALE AS SHOWN
DRAWING NUMBER
CT-1-4722
SHEET 3 OF 5


PLATE G-17

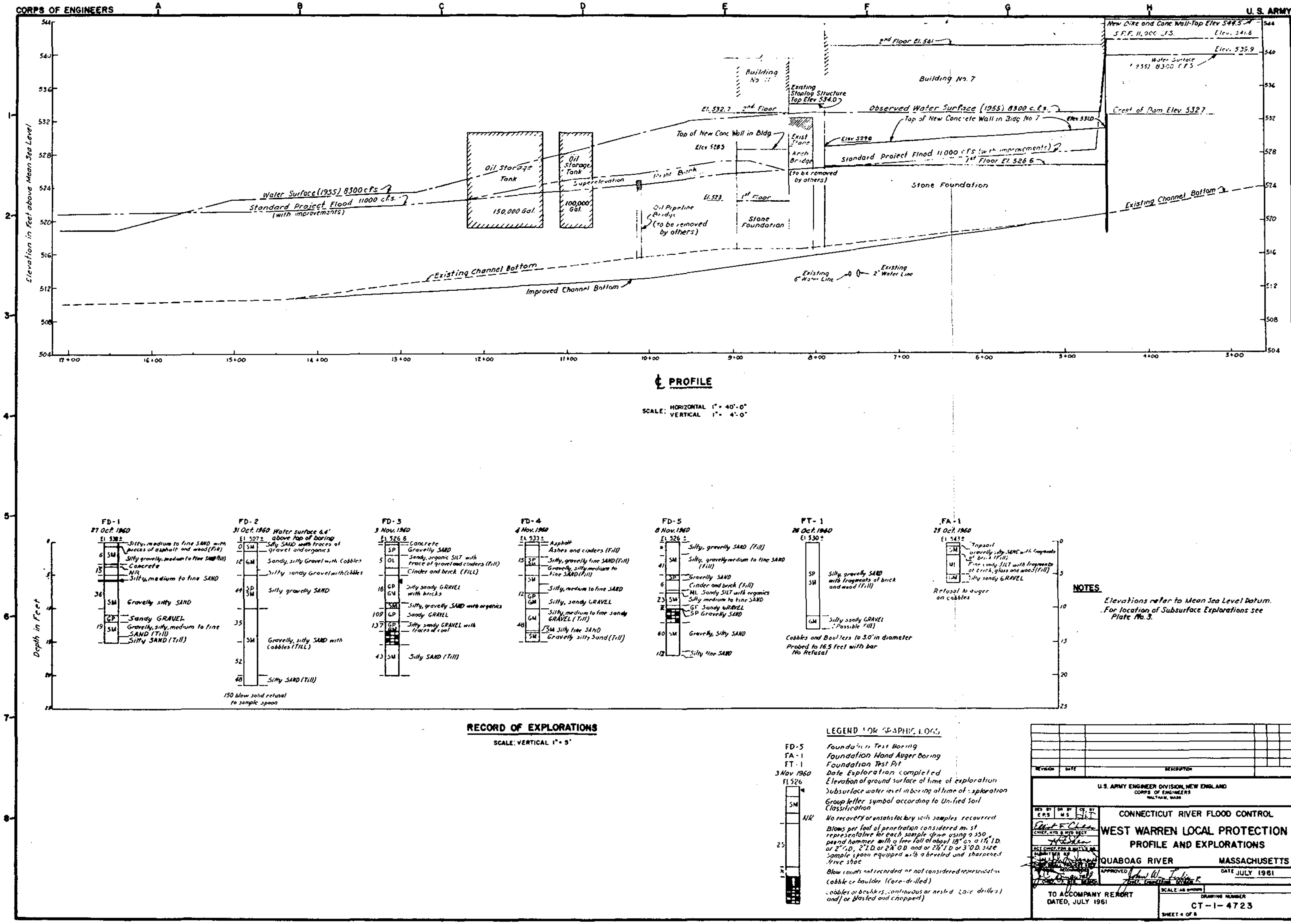
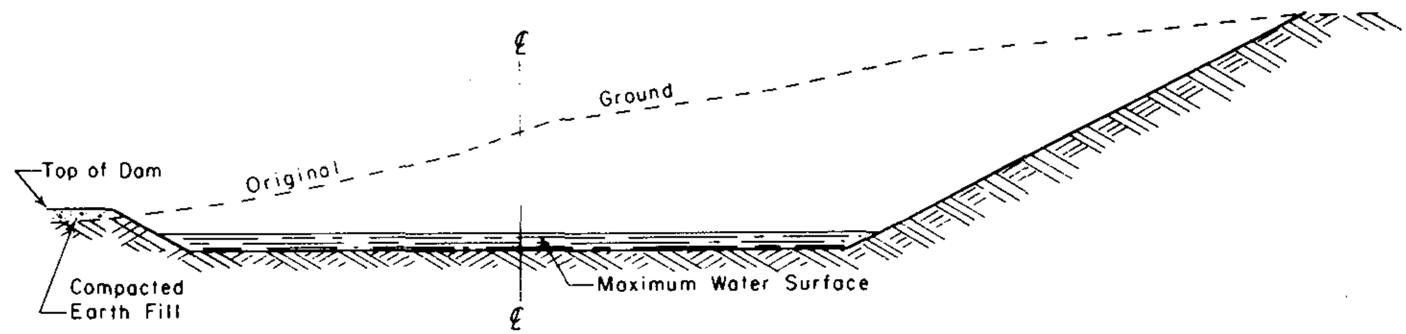
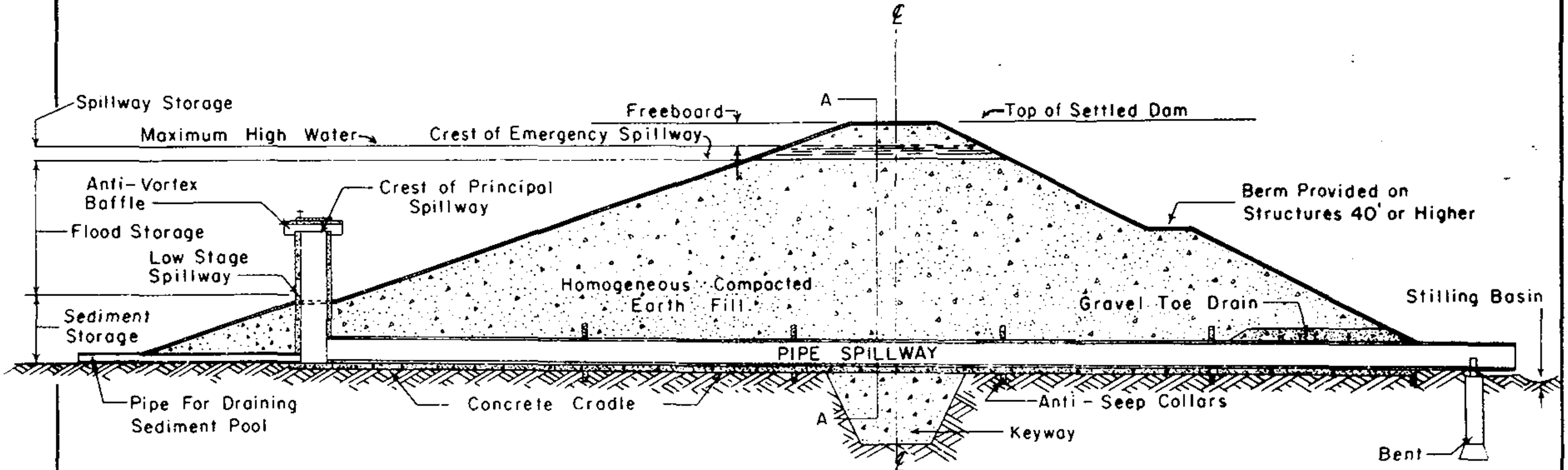

CORPS OF ENGINEERS
U. S. ARMY
Elevation in Feet above Mean Sea Level
New Dike and Conc Wall-Top Elev 546.5
S.P.F. 11,000 c.f.s.
Water Surface 1955 8300 c.f.s.
2nd Floor El. 541
Building No. 7
Building No. 11
Existing Stoplog Structure Top Elev 534.0
Observed Water Surface (1955) 8300 c.f.s.
Top of New Concrete Wall in Bldg No 7
Crest of Dam Elev 532.7
Top of New Conc Wall in Bldg.
Exist Stone Arch Bridge
Standard Project Flood 11,000 c.f.s. (with improvements)
1st Floor El. 526.6
(to be removed by others)
Stone Foundation
Oil Storage Tank
150,000 Gal.
100,000 Gal.
Superelevation
Right Bank
Water Surface (1955) 8300 cfs
Standard Project Flood 11000 c.f.s. (with improvements)
Oil Pipeline Bridge (to be removed by others)
Existing Channel Bottom
Improved Channel Bottom
Existing 6" Water Line
Existing 2" Water Line
℄ PROFILE
SCALE: HORIZONTAL 1" = 40'-0" VERTICAL 1" = 4'-0"
Depth in Feet
FD-1 27 Oct. 1960
FD-2 31 Oct. 1960
FD-3 3 Nov. 1960
FD-4 4 Nov. 1960
FD-5 8 Nov. 1960
FT-1 26 Oct. 1960
FA-1 25 Oct. 1960
Silty, medium to fine SAND with pieces of asphalt and wood (Fill)
Concrete
Silty, medium to fine SAND
Gravelly silty SAND
Sandy GRAVEL
Gravelly, silty, medium to fine SAND (Till)
Silty SAND (Till)
Water surface 6.4' above top of boring
Silty SAND with traces of gravel and organics
Sandy, silty Gravel with Cobbles
Silty sandy Gravel with Cobbles
Silty gravelly SAND
Gravelly, silty SAND with cobbles (TILL)
Silty SAND (Till)
150 blow solid refusal to sample spoon
Gravelly SAND
Sandy, organic SILT with traces of gravel and cinders (Fill)
Cinder and brick (FILL)
Silty sandy GRAVEL with bricks
Silty, gravelly SAND with organics
Sandy GRAVEL
Silty sandy GRAVEL with traces of coal
Silty SAND (Till)
Asphalt
Ashes and cinders (Fill)
Silty, gravelly fine SAND (Fill)
Gravelly, silty medium to fine SAND (Fill)
Silty, medium to fine SAND
Silty, sandy GRAVEL
Silty, medium to fine sandy GRAVEL (Till)
Silty fine SAND
Gravelly silty Sand (Till)
Silty, gravelly SAND (Fill)
Silty, gravelly medium to fine SAND (Fill)
Gravelly SAND
Cinder and brick (Fill)
Sandy SILT with organics
Silty medium to fine SAND
Sandy GRAVEL
Gravelly SAND
Gravelly, Silty SAND
Silty fine SAND
Silty gravelly SAND with fragments of brick and wood (Fill)
Silty sandy GRAVEL (Possible Fill)
Cobbles and Boulders to 3.0' in diameter
Probed to 16.5 feet with bar No Refusal
Topsoil
Gravelly silty SAND with fragments of brick (Fill)
Fine sandy SILT with fragments of brick, glass and wood (Fill)
Silty sandy GRAVEL
Refusal to auger on cobbles
NOTES
Elevations refer to Mean Sea Level Datum.
For location of Subsurface Explorations see Plate No. 3.
RECORD OF EXPLORATIONS
SCALE: VERTICAL 1" = 5'
LEGEND FOR GRAPHIC LOGS
FD-5 Foundation Test Boring
FA-1 Foundation Hand Auger Boring
FT-1 Foundation Test Pit
3 Nov 1960 Date Exploration completed
El. 526 Elevation of ground surface at time of exploration
Subsurface water level in boring at time of exploration
SM Group letter symbol according to Unified Soil Classification
NR No recovery or unsatisfactory soils samples recovered
25 Blows per foot of penetration considered most representative for each sample drive using a 350 pound hammer with a free fall of about 18" on a 1⅞" I.D. or 2" O.D., 2⅞" I.D. or 2⅜" O.D. and or 2¾" I.D. or 3" O.D. size sample spoon equipped with a beveled and sharpened drive shoe
Blow counts not recorded or not considered representative
Cobble or boulder (Core-drilled)
Cobbles or boulders, continuous or nested (core drilled) and/or blasted and chopped
REVISION DATE DESCRIPTION
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
CONNECTICUT RIVER FLOOD CONTROL
WEST WARREN LOCAL PROTECTION
PROFILE AND EXPLORATIONS
QUABOAG RIVER MASSACHUSETTS
DATE JULY 1961
TO ACCOMPANY REPORT DATED, JULY 1961
SCALE: AS SHOWN
DRAWING NUMBER
CT-1-4723
SHEET 4 OF 6

PLATE G-18

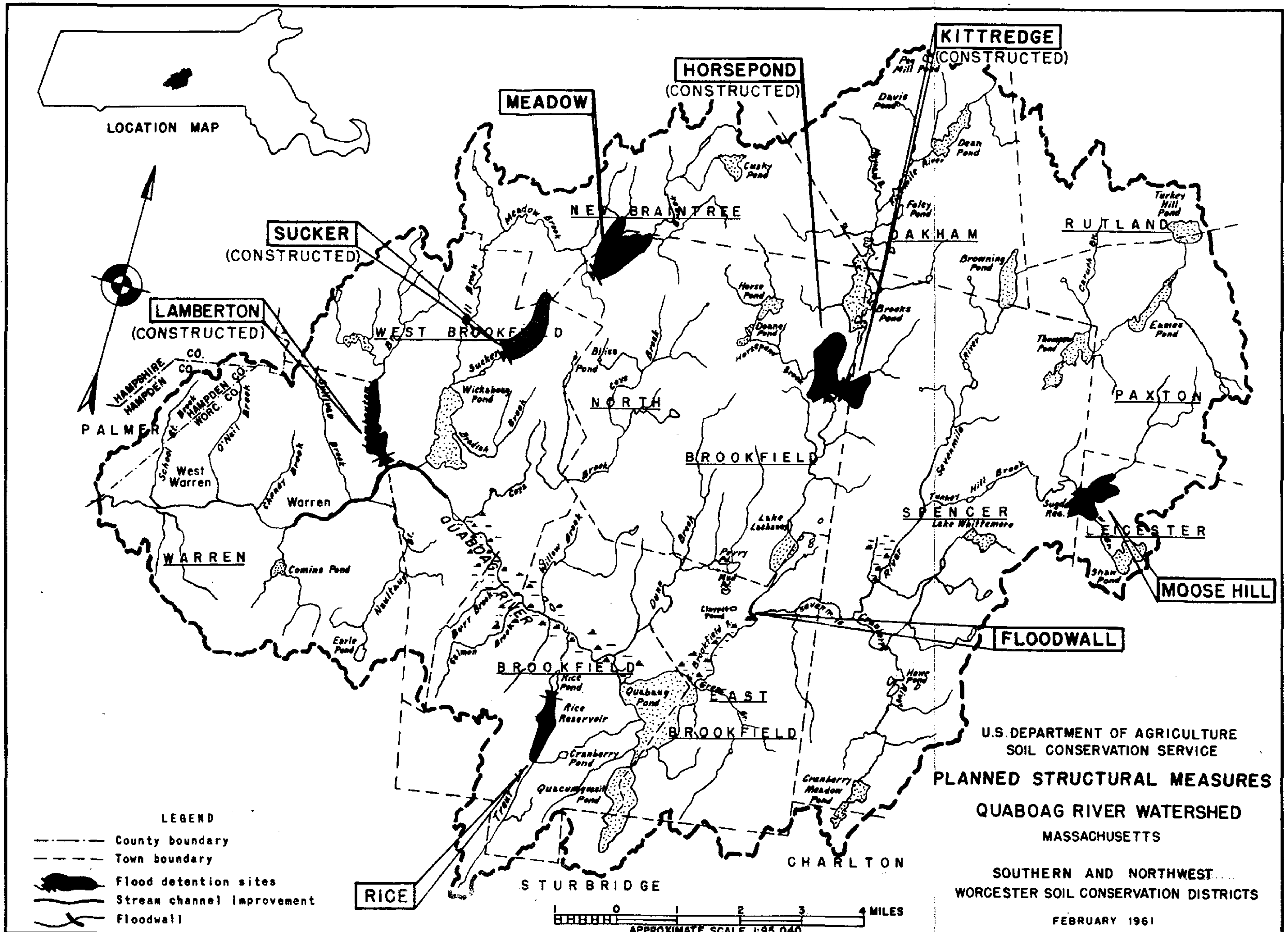



SECTION A-A
CROSS SECTION OF EMERGENCY SPILLWAY
CONTROL SECTION




TYPICAL CROSS SECTION OF FLOODWATER RETARDING STRUCTURE
ALONG PRINCIPAL AND EMERGENCY SPILLWAYS
U.S. SOIL CONSERVATION SERVICE

PLATE G-19




U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

**PLANNED STRUCTURAL MEASURES**

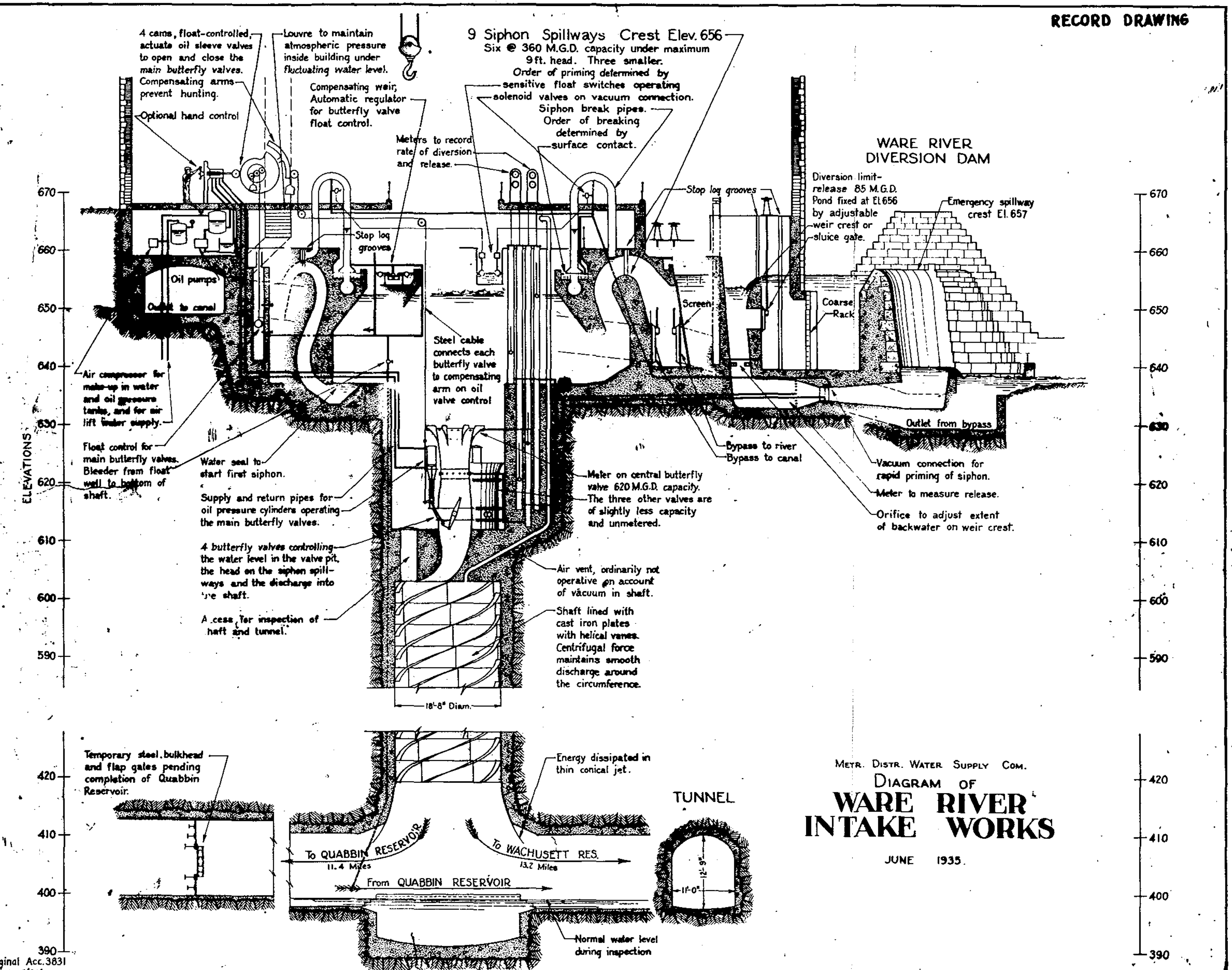
**QUABOAG RIVER WATERSHED**

MASSACHUSETTS

SOUTHERN AND NORTHWEST WORCESTER SOIL CONSERVATION DISTRICTS

FEBRUARY 1961

PLATE G-20




METR. DISTR. WATER SUPPLY COM.

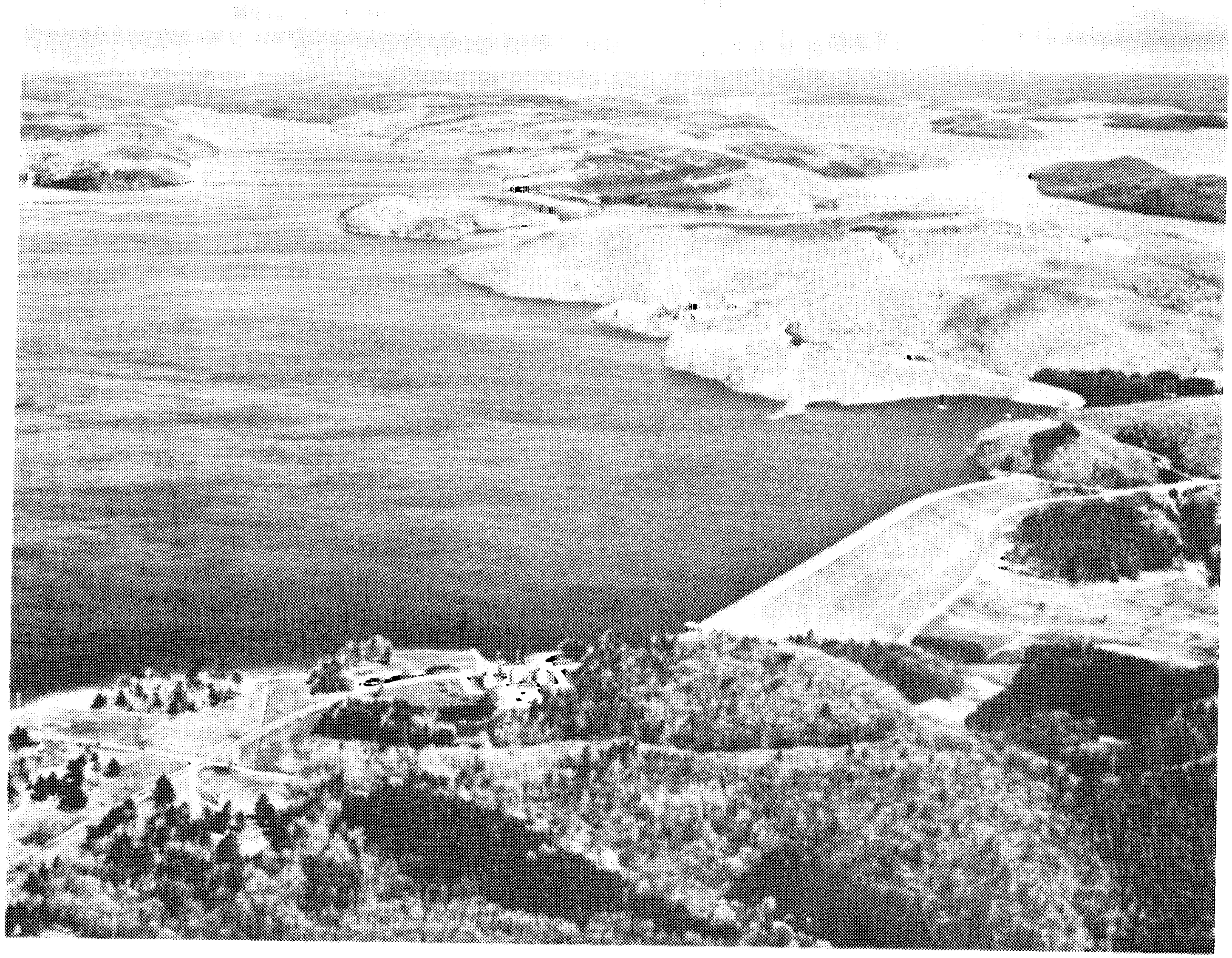
DIAGRAM OF

# WARE RIVER INTAKE WORKS

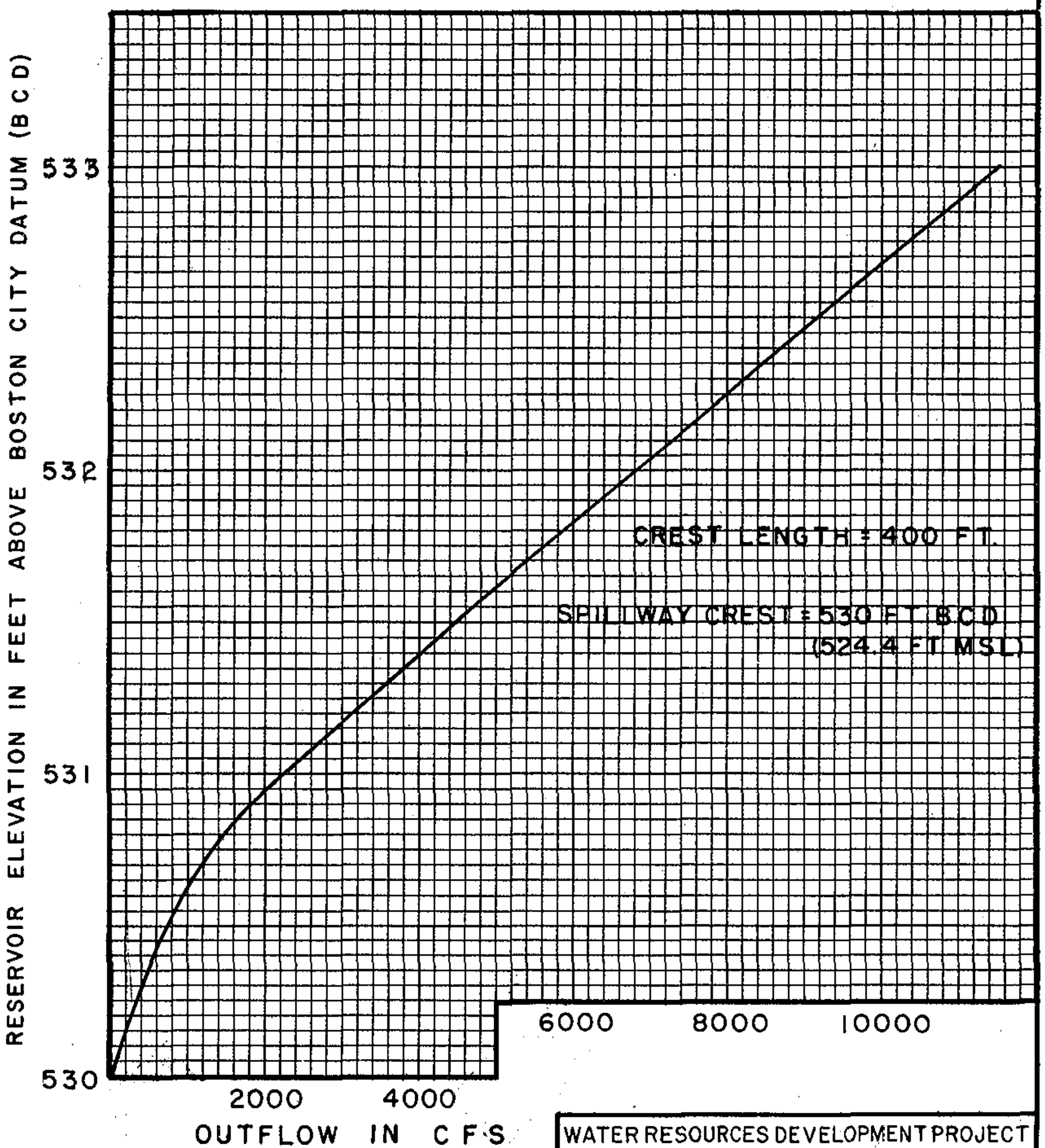
JUNE 1935.

Original Acc. 3831
Drawn: KCK
Traced: RHS.

File 23.32 W



VIEW OF QUABBIN RESERVOIR




NOTES:

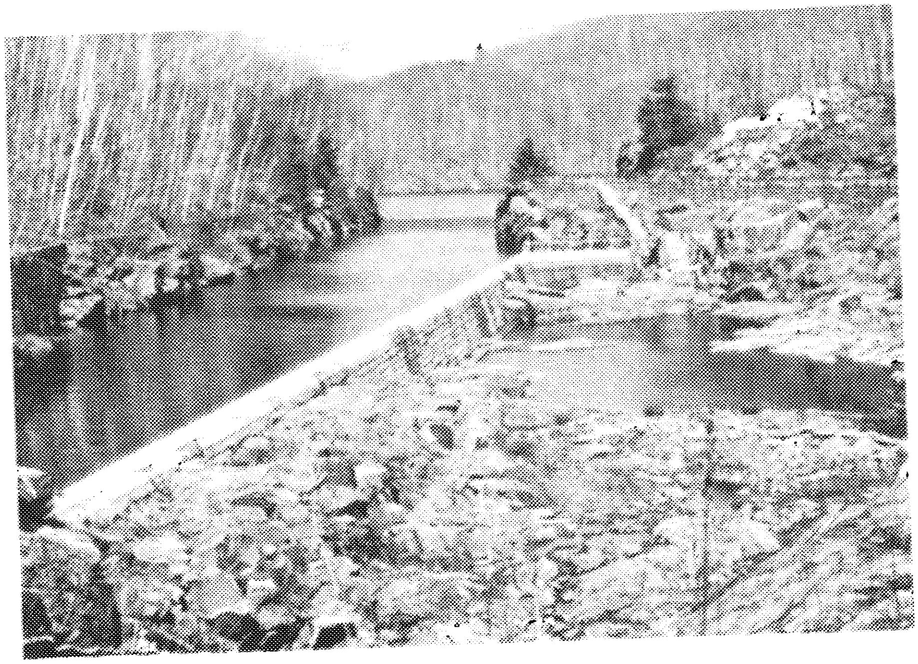
CURVE WAS DEVELOPED FROM INFORMATION PROVIDED BY MASSACHUSETTS MDC. REFER TO PARAGRAPH 3e FOR EXPLANATION OF CURVE.

WATER RESOURCES DEVELOPMENT PROJECT

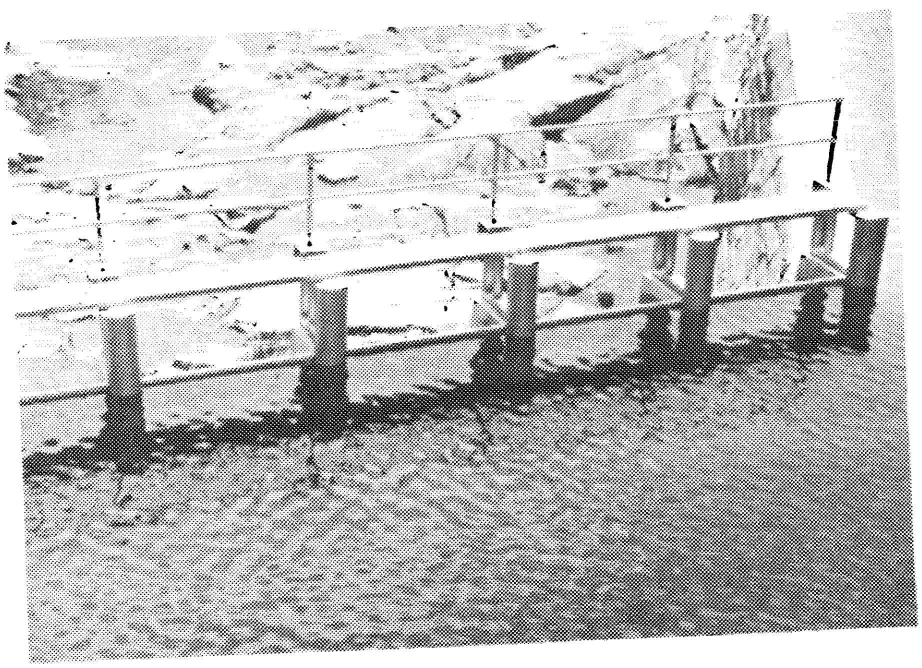
# CONNECTICUT RIVER BASIN QUABBIN RESERVOIR

# SPILLWAY RATING CURVE

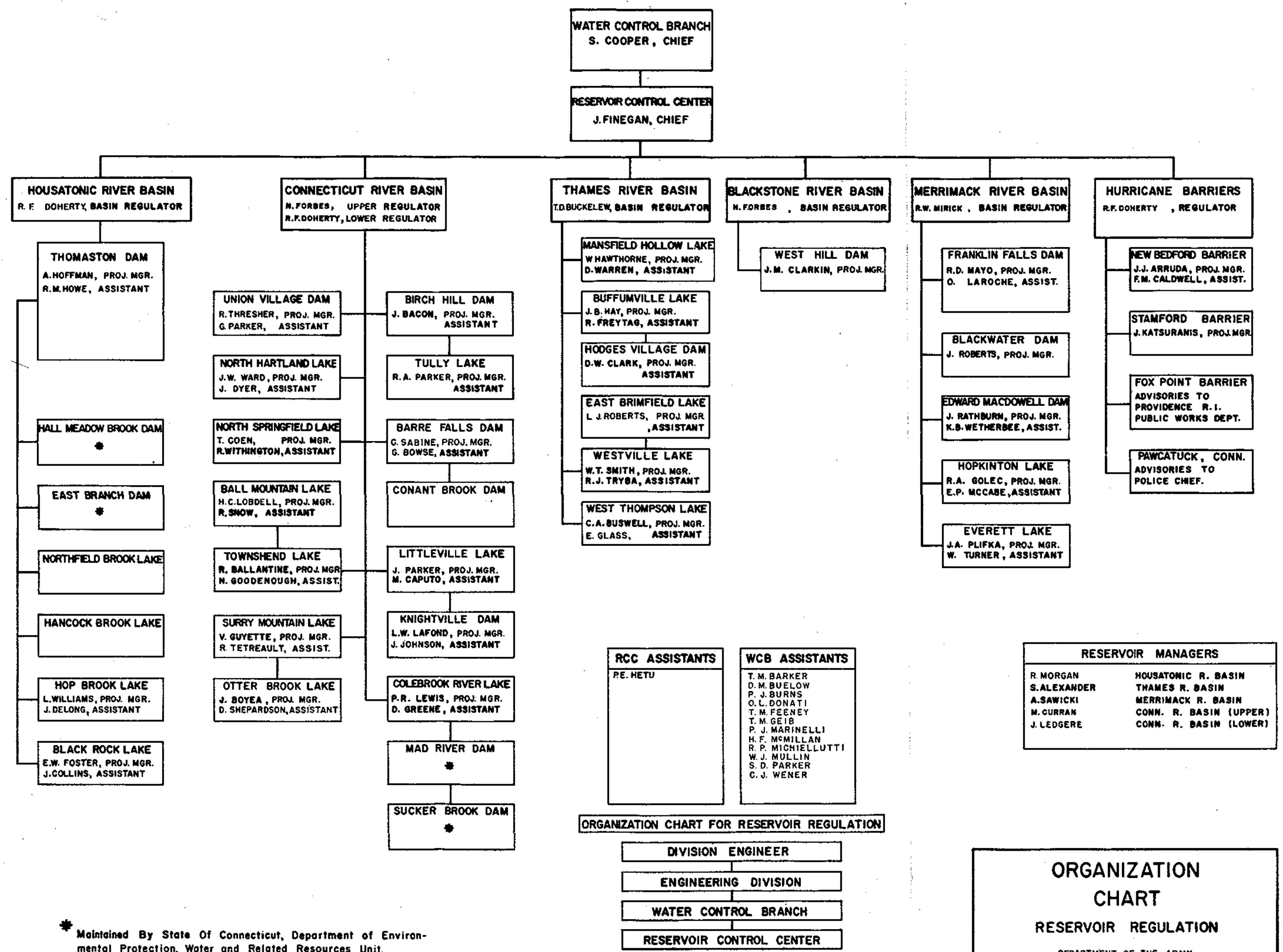
NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978



SPILLWAY - QUABBIN RESERVOIR



STOPLOGS - SPILLWAY, QUABBIN RESERVOIR




* Maintained By State Of Connecticut, Department of Environmental Protection, Water and Related Resources Unit.

# ORGANIZATION CHART

## RESERVOIR REGULATION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
JAN. 1979

CORPS OF ENGINEERS U. S. ARMY

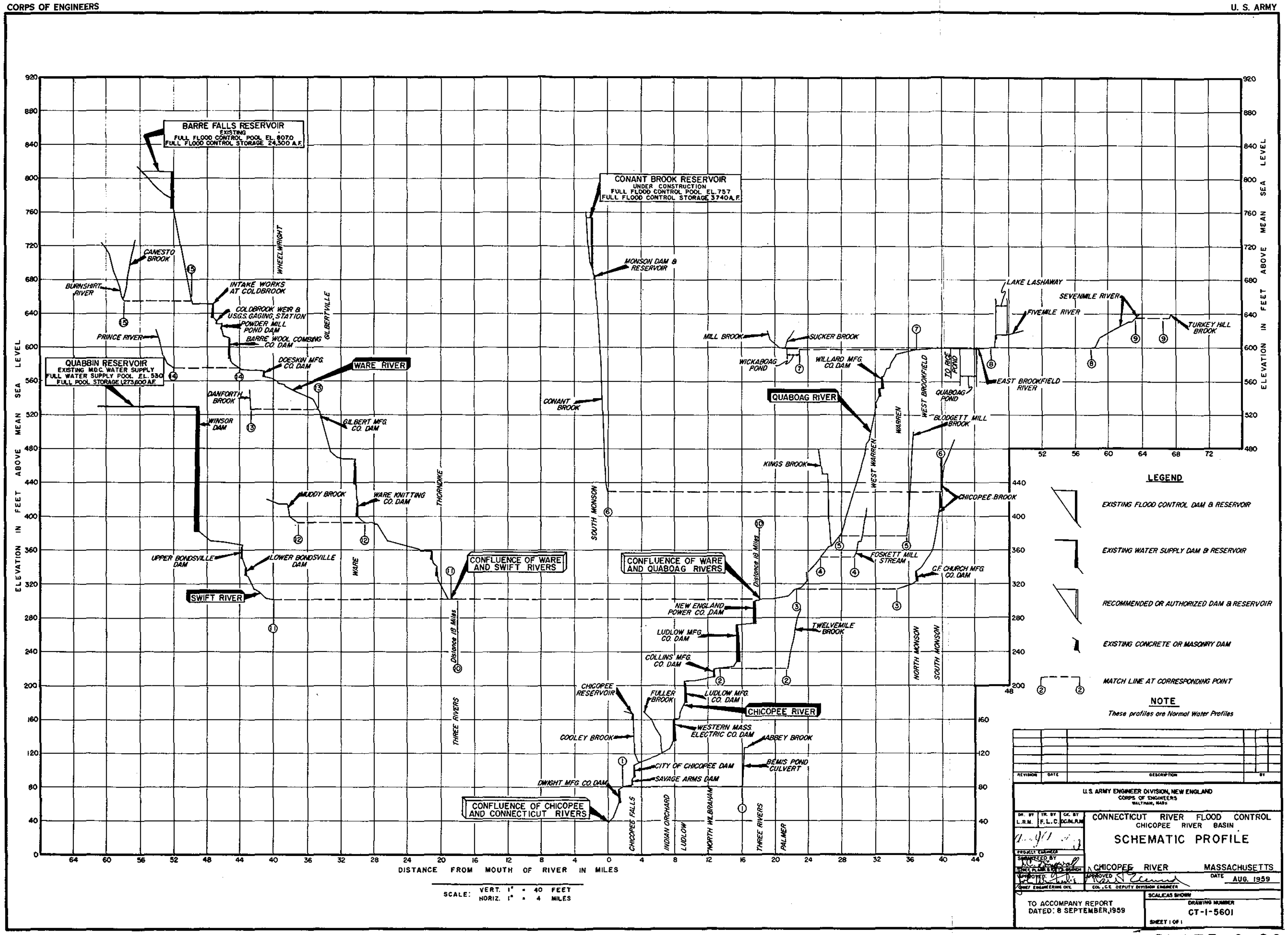
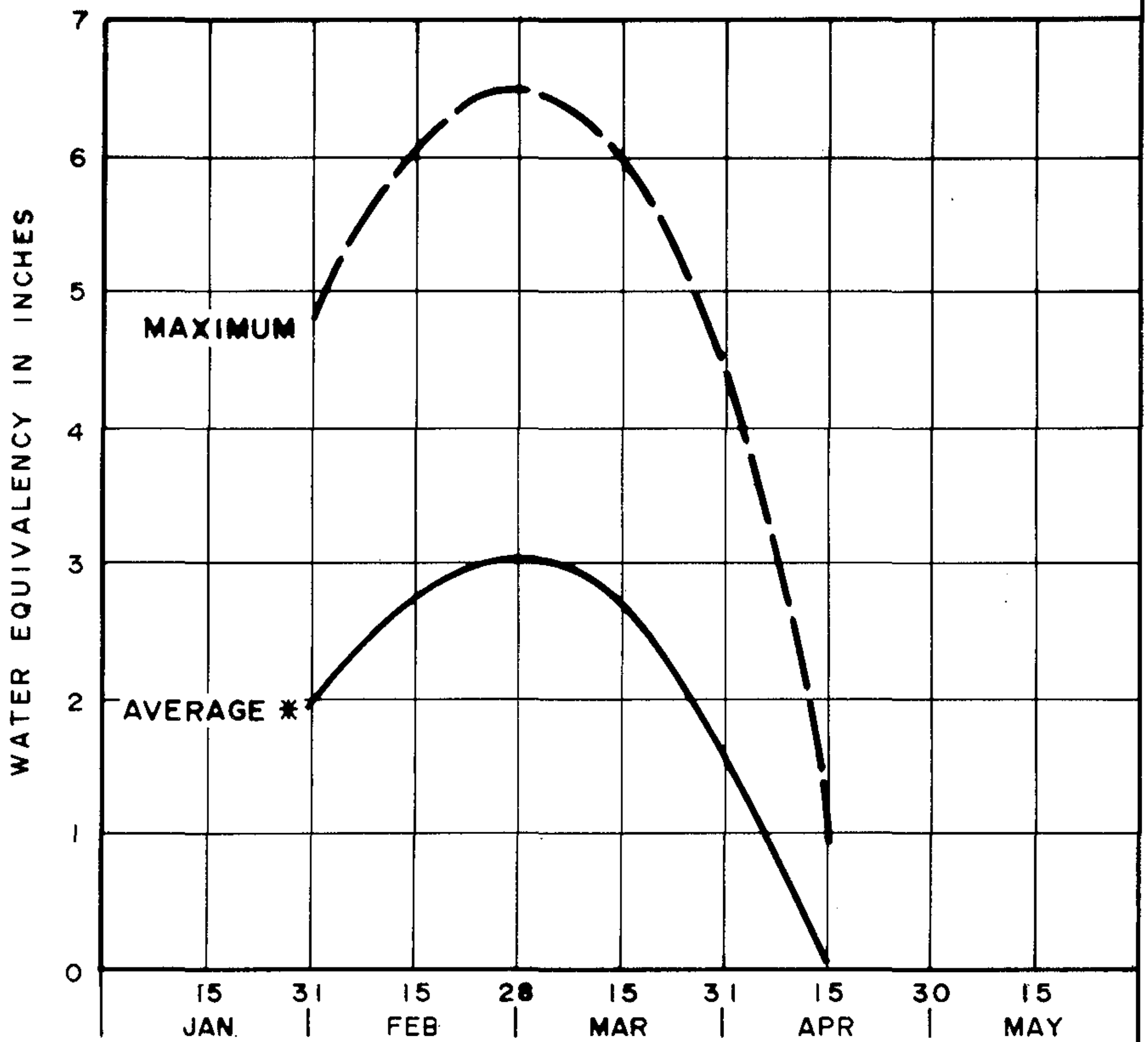



PLATE G-26

ANNUAL PRECIPITATION
CHICOPEE RIVER WATERSHED
(DEPTH IN INCHES)

| Calendar Year | Ware, Mass. (Elevation 410 ft. msl) 1920-1976 | Hardwick, Mass. (Elevation 990 ft. msl) 1920-1976 | Southbridge, Mass. (Elevation 740 ft. msl) 1912-1978 |
|---|---|---|---|
| 1911 | | | |
| 1912 | | | 47.3 |
| 1913 | | | 44.5 |
| 1914 | | | 33.2 |
| 1915 | | | 42.3 |
| 1916 | | | 39.8 |
| 1917 | | | 36.5 |
| 1918 | | | 40.7 |
| 1919 | | | 59.4 |
| 1920 | 52.8 | | 56.4 |
| 1921 | 42.0 | 48.9 | 42.8 |
| 1922 | 45.4 | 46.4 | 49.2 |
| 1923 | 46.2 | 42.5 | 44.6 |
| 1924 | 32.3 | 40.0 | 38.4 |
| 1925 | 39.0 | 41.2 | 40.6 |
| 1926 | 33.9 | 37.1 | 43.3 |
| 1927 | 52.3 | 53.1 | 50.9 |
| 1928 | 37.0 | 42.4 | 42.0 |
| 1929 | 40.5 | 36.8 | 40.7 |
| 1930 | 30.9 | 32.2 | 31.4 |
| 1931 | - | 42.0 | 40.8 |
| 1932 | - | 42.2 | 49.8 |
| 1933 | - | 50.6 | 55.9 |
| 1934 | - | 50.4 | 52.8 |
| 1935 | - | 40.0 | 40.9 |
| 1936 | - | 57.7 | 57.4 |
| 1937 | - | 53.2 | 58.6 |
| 1938 | 56.0 | 60.0 | 67.4 (a) |
| 1939 | 36.4 | - | 49.0 |
| 1940 | 45.5 | 42.7 | 49.4 |
| 1941 | 34.3 | 31.7 | 40.1 |
| 1942 | 46.6 | 44.6 | 49.5 |
| 1943 | 43.6 | 39.9 | 41.2 |
| 1944 | 41.9 | - | 44.2 |
| 1945 | 54.4 | 51.0 | 46.9 |
| 1946 | 40.6 | - | 45.5 |
| 1947 | - | - | 43.4 |
| 1948 | 45.4 | 46.4 | 46.6 |
| 1949 | - | 35.2 | 34.6 |
| 1950 | - | 42.2 | 47.0 |
| 1951 | 46.8 | - | 52.0 |
| 1952 | 40.9 | 40.7 | 49.2 |
| 1953 | 53.3 | 48.3 | 58.2 |
| 1954 | 53.6 | 48.6 | 56.2 |
| 1955 | 60.0 (a) | 54.3 | 60.6 |
| 1956 | 36.6 | 41.2 | 41.9 |
| 1957 | 32.0 | 34.6 | 34.9 |
| 1958 | 43.5 | 45.8 | 54.2 |
| 1959 | 48.6 | 52.2 | 55.1 |
| 1960 | 48.0 | 48.6 | 52.0 |
| 1961 | 38.8 | 44.9 | 44.7 |
| 1962 | 37.0 | 38.7 | 46.5 |
| 1963 | 36.4 | 36.7 | 40.5 |
| 1964 | 31.4 | 31.2 | 36.9 |
| 1965 | 26.4 (b) | 30.5 (b) | 32.1 (b) |
| 1966 | 34.9 | 36.2 | 43.6 |
| 1967 | 43.5 | 46.2 | 49.3 |
| 1968 | 39.0 | 40.0 | 46.3 |
| 1969 | 46.2 | 46.6 | 53.9 |
| 1970 | 41.9 | 43.0 | 45.0 |
| 1971 | 41.2 | 43.4 | 45.1 |
| 1972 | 57.8 | 55.1 | 65.0 |
| 1973 | 51.0 | 51.0 | 55.1 |
| 1974 | 52.8 | 49.2 | 55.0 |
| 1975 | 52.4 | 58.4 | 55.5 |
| 1976 | 41.6 | 44.7 | 46.4 |
| Mean | 44.6 | 44.9 | 46.4 |

(a) Maximum annual precipitation
(b) Minimum annual precipitation




* PERIOD OF RECORD: 1957 - 1978

NOTE:
MINIMUM WATER EQUIVALENT = 0.0

WATER RESOURCES DEVELOPMENT PROJECT
CONNECTICUT RIVER BASIN
CHICOPEE RIVER WATERSHED

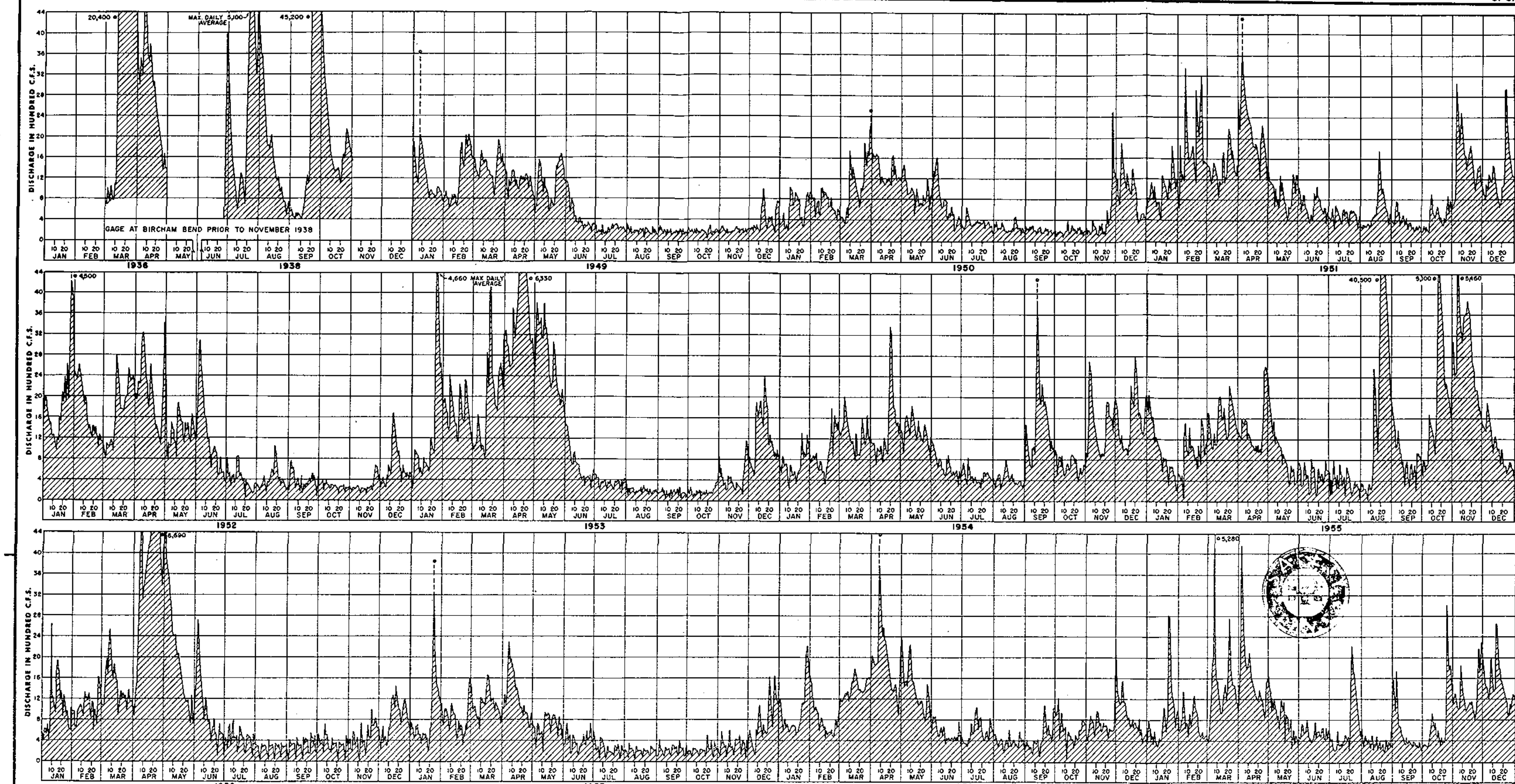
**WATER EQUIVALENT OF SNOW COVER**

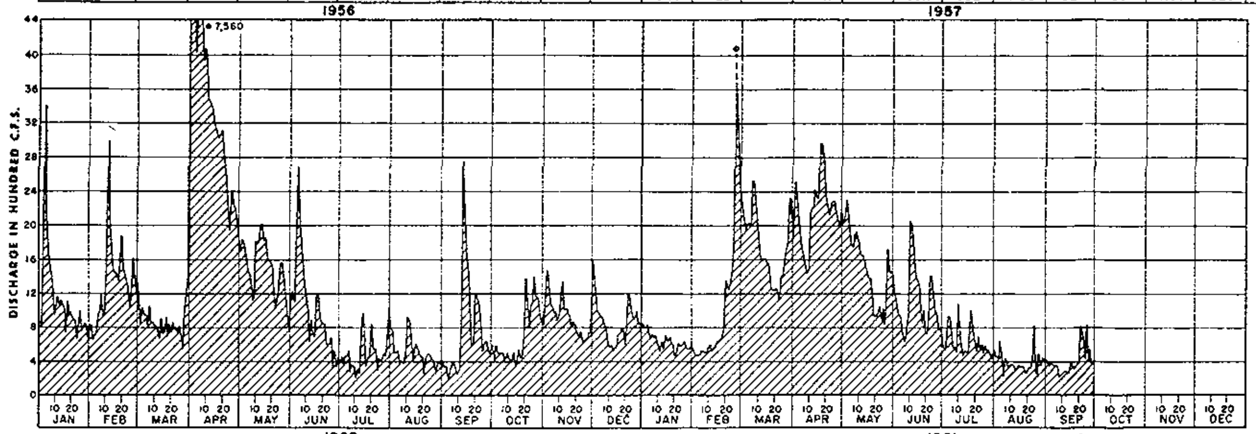
NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978

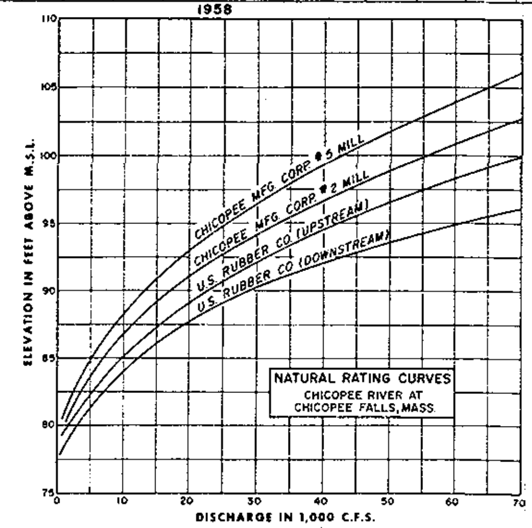
PLATE G-28

CORPS OF ENGINEERS

U. S. ARMY




## NOTES:

*These hydrographs are daily average stream flow record of Chicopee River at Indian Orchard from the tributary drainage area of 688 Sq. Mi.*

*The drainage area of Chicopee River at Chicopee Falls is 720 Sq. Mi.*

*Instantaneous peak discharges where available are shown by ⊙.*

*The data contained hereon are not intended as representations or warrenties but are furnished for information only. It is expressly understood that the Government will not be responsible for any deduction, interpretation or conclusion therefrom made by any bidder or contractor.*

*Additional daily average flows from 1928 to 1948 are available at the Corps of Engineers or with the United States Geological Survey.*

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

| DR. BY | TR. BY | CK. BY |
|---|---|---|
| P.J.B. | M.S. | R.W.M. |

SUBMITTED — CHIEF, SECTION

PROJECT ENGINEER

APPROVAL RECOMMENDED — CHIEF, HYD. & HYD. SEC.

APPROVAL RECOMMENDED — CHIEF, P & R BRANCH

APPROVED — CHIEF ENGINEERING DIV.

CHICOPEE RIVER FLOOD CONTROL

# INDIAN ORCHARD

## HYDROGRAPHS

CHICOPEE RIVER MASSACHUSETTS

DATE APRIL, 1963

SCALE

SPEC. NO. CIV. ENG.-19-016-63-62

DRAWING NUMBER CT 5885

SHEET 58

# ANNUAL RUNOFF
## CHICOPEE RIVER WATERSHED

| Water Year | Ware River at Barre, Mass. D.A. = 55 sq. mi. 1946-1977 | | Ware River at Gibbs Crossing D.A. = 199 sq. mi. 1912-1977 | | Quaboag River at W. Brimfield, Mass. D.A. = 151 sq. mi. 1913-1977 | | Chicopee River at Indian Orchard D.A. = 688 sq. mi. 1928-1977 | |
|---|---|---|---|---|---|---|---|---|
| | CFS | Inches | CFS | Inches | CFS | Inches | CFS | Inches |
| 1913 | | | 259 | 17.6 | | | | |
| 1914 | | | 315 | 21.5 | 233 | 21.0 | | |
| 1915 | | | 207 | 14.1 | 171 | 15.4 | | |
| 1916 | | | 407 | 27.8 | 298 | 26.8 | | |
| 1917 | | | 300 | 20.5 | 219 | 19.7 | | |
| 1918 | | | 245 | 16.7 | 178 | 16.0 | | |
| 1919 | | | 354 | 24.2 | 252 | 22.7 | | |
| 1920 | | | 423 | 20.9 | 362 | 32.6 | | |
| 1921 | | | 379 | 25.9 | 276 | 24.8 | | |
| 1922 | | | 394 | 26.9 | 267 | 24.0 | | |
| 1923 | | | 307 | 21.0 | 257 | 23.1 | | |
| 1924 | | | 314 | 21.4 | 276 | 24.8 | | |
| 1925 | | | 206 | 14.1 | 148 | 13.3 | | |
| 1926 | | | 282 | 19.3 | 171 | 15.4 | | |
| 1927 | | | 314 | 21.4 | 206 | 18.5 | | |
| 1928 | | | 461 | 31.5 | 339 | 30.5 | | |
| 1929 | | | 311 | 21.2 | 228 | 20.5 | 1099 | 21.7 |
| 1930 | | | 161 | 11.0 | 104(b) | 9.4(b) | 589 | 11.6 |
| 1931 | | | 175 | 11.9 | 161 | 14.5 | 684 | 13.5 |
| 1932 | | | 192 | 13.1 | 169 | 15.2 | 764 | 15.1 |
| 1933 | | | 378 | 25.8 | 293 | 26.4 | 1287 | 25.4 |
| 1934 | | | 343 | 23.4 | 264 | 23.8 | 1234 | 24.4 |
| 1935 | | | 351 | 24.0 | 275 | 24.7 | 1215 | 24.0 |
| 1936 | | | 347 | 23.7 | 272 | 24.5 | 1213 | 24.0 |
| 1937 | | | 380 | 25.9 | 268 | 24.1 | 1345 | 26.6 |
| 1938 | | | 581(a) | 39.7(a) | 430(a) | 38.7(a) | 1952(a) | 38.6(a) |
| 1939 | | | 363 | 24.8 | 273 | 24.6 | 1287 | 25.4 |
| 1940 | | | 216 | 14.7 | 241 | 21.7 | 725 | 14.3 |
| 1941 | | | 164 | 11.2 | 131 | 11.8 | 460 | 9.1 |
| 1942 | | | 191 | 13.0 | 170 | 15.3 | 549 | 10.8 |
| 1943 | | | 256 | 17.5 | 256 | 23.0 | 823 | 16.3 |
| 1944 | | | 214 | 14.4 | 179 | 16.1 | 599 | 11.8 |
| 1945 | | | 307 | 21.0 | 282 | 25.4 | 867 | 17.1 |
| 1946 | | | 259 | 17.7 | 244 | 22.0 | 746 | 14.7 |
| 1947 | 82.8 | 20.4 | 259 | 17.7 | 224 | 20.1 | 765 | 15.1 |
| 1948 | 99.6 | 24.6 | 297 | 20.3 | 279 | 25.1 | 997 | 19.7 |
| 1949 | 74.7 | 18.4 | 240 | 16.4 | 171 | 15.3 | 701 | 13.8 |
| 1950 | 65.6 | 16.2 | 200 | 13.7 | 155 | 13.9 | 605 | 11.9 |
| 1951 | 96.6 | 23.8 | 291 | 19.9 | 254 | 22.8 | 927 | 18.3 |
| 1952 | 116 | 28.6 | 400 | 27.3 | 322 | 29.0 | 1241 | 24.5 |
| 1953 | 112 | 27.6 | 334 | 22.8 | 306 | 27.5 | 1156 | 22.8 |
| 1954 | 104 | 25.7 | 295 | 20.1 | 254 | 22.8 | 881 | 17.4 |
| 1955 | 101 | 24.9 | 407 | 27.8 | 400 | 36.0 | 1259 | 24.9 |
| 1956 | 133 | 32.8 | 466 | 31.8 | 357 | 32.1 | 1483 | 29.3 |
| 1957 | 61.2 | 15.1 | 213 | 14.5 | 155 | 13.9 | 624 | 12.3 |
| 1958 | 101 | 24.9 | 248 | 16.9 | 260 | 23.4 | 826 | 16.3 |
| 1959 | 85.6 | 21.1 | 263 | 18.0 | 241 | 21.7 | 831 | 16.4 |
| 1960 | 124 | 30.6 | 397 | 27.1 | 311 | 28.0 | 1224 | 24.2 |
| 1961 | 95.4 | 23.6 | 303 | 20.7 | 251 | 22.6 | 1007 | 19.9 |
| 1962 | 75.2 | 18.6 | 207 | 14.1 | 187 | 16.8 | 677 | 13.4 |
| 1963 | 73.2 | 18.1 | 205 | 14.0 | 215 | 19.3 | 648 | 12.8 |
| 1964 | 64.3 | 15.9 | 167 | 11.4 | 173 | 15.6 | 555 | 11.0 |
| 1965 | 29.5(b) | 7.3(b) | 107(b) | 7.3(b) | 104(b) | 9.4(b) | 396 | 7.8 |
| 1966 | 36.5 | 9.0 | 122 | 8.3 | 108 | 9.7 | 376(b) | 7.4(b) |
| 1967 | 82.9 | 20.5 | 245 | 16.7 | 223 | 20.1 | 684 | 13.5 |
| 1968 | 88.0 | 21.7 | 242 | 16.5 | 223 | 20.1 | 712 | 14.1 |
| 1969 | 87.3 | 21.6 | 209 | 14.3 | 213 | 19.2 | 665 | 13.1 |
| 1970 | 105 | 25.9 | 266 | 10.2 | 287 | 25.8 | 922 | 18.2 |
| 1971 | 65.8 | 16.2 | 200 | 13.7 | 179 | 16.1 | 601 | 11.9 |
| 1972 | 126 | 31.1 | 327 | 22.3 | 352 | 31.7 | 1049 | 20.7 |
| 1973 | 132(a) | 32.6(a) | 319 | 21.8 | 333 | 30.0 | 1066 | 21.0 |
| 1974 | 96.5 | 23.8 | 257 | 17.5 | 257 | 23.1 | 842 | 16.6 |
| 1975 | 106 | 26.2 | 292 | 19.9 | 284 | 25.6 | 953 | 18.8 |
| 1976 | 119 | 29.4 | 384 | 26.2 | 317 | 28.5 | 1165 | 23.0 |
| 1977 | 73.3 | 18.1 | 210 | 14.3 | 197 | 17.7 | 648 | 12.8 |
| Average | 90.5 | 22.4 | 288 | 19.7 | 241 | 21.7 | 896 | 17.7 |

(a) Maximum Annual Runoff
(b) Minimum Annual Runoff

Table No. __ __

Begin __ __ __ __
YR. MO. D. HR

*Rating table for* Connecticut River at Montague City

*from* ________ *to* ________, *from* ________ *to* ________, *from* ________ *to* ________

| Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs |
| 3.00 | | | 5.00 | 1100 | 100 | 7.00 | 3620 | 150 | 9.00 | 7240 | 210 | 11.00 | 12000 | 250 | 13.00 | 17,800 | 320 | 15.00 | 24,200 | 320 |
| .10 | | | .10 | 1200 | 100 | .10 | 3770 | 150 | .10 | 7450 | 210 | .10 | 12250 | 250 | .10 | 18,120 | | .10 | 24,520 | |
| .20 | | | .20 | 1300 | 110 | .20 | 3920 | 160 | .20 | 7660 | 220 | .20 | 12500 | 250 | .20 | 18,440 | | .20 | 24,840 | |
| .30 | | | .30 | 1410 | 110 | .30 | 4080 | 160 | .30 | 7880 | 230 | .30 | 12750 | 270 | .30 | 18,760 | | .30 | 25,160 | |
| .40 | | | .40 | 1520 | 120 | .40 | 4240 | 170 | .40 | 8110 | | .40 | 13020 | 280 | .40 | 19,080 | | .40 | 25,480 | |
| .50 | | | .50 | 1640 | 120 | .50 | 4410 | 170 | .50 | 8340 | | .50 | 13300 | 300 | .50 | 19,400 | | .50 | 25,800 | |
| .60 | | | .60 | 1760 | 120 | .60 | 4580 | 180 | .60 | 8570 | | .60 | 13600 | | .60 | 19,720 | | .60 | 26,120 | |
| .70 | 205 | 40 | .70 | 1880 | 120 | .70 | 4760 | | .70 | 8800 | | .70 | 13900 | | .70 | 20,040 | | .70 | 26,440 | |
| .80 | 245 | 45 | .80 | 2000 | 130 | .80 | 4940 | | .80 | 9030 | 230 | .80 | 14200 | | .80 | 20,360 | | .80 | 26,760 | |
| .90 | 290 | 50 | .90 | 2130 | 130 | .90 | 5120 | | .90 | 9260 | 240 | .90 | 14500 | | .90 | 20,680 | | .90 | 27,080 | |
| 4.00 | 340 | 55 | 6.00 | 2260 | 130 | 8.00 | 5300 | 180 | 10.00 | 9500 | 250 | 12.00 | 14800 | | 14.00 | 21,000 | | 16.00 | 27,400 | |
| .10 | 395 | 60 | .10 | 2390 | 130 | .10 | 5480 | | .10 | 9750 | | .10 | 15100 | | .10 | 21,320 | | .10 | 27,720 | |
| .20 | 455 | 65 | .20 | 2520 | 130 | .20 | 5670 | | .20 | 10000 | | .20 | 15400 | | .20 | 21,640 | | .20 | 28,040 | |
| .30 | 520 | 70 | .30 | 2650 | 130 | .30 | 5860 | | .30 | 10250 | | .30 | 15700 | | .30 | 21,960 | | .30 | 28,360 | |
| .40 | 590 | 70 | .40 | 2780 | 130 | .40 | 6050 | 190 | .40 | 10500 | | .40 | 16000 | | .40 | 22,280 | | .40 | 28,680 | |
| .50 | 660 | 80 | .50 | 2910 | 140 | .50 | 6240 | 200 | .50 | 10750 | | .50 | 16300 | | .50 | 22,600 | | .50 | 29,000 | |
| .60 | 740 | 80 | .60 | 3050 | 140 | .60 | 6440 | | .60 | 11000 | | .60 | 16600 | | .60 | 22,920 | | .60 | 29,320 | |
| .70 | 820 | 90 | .70 | 3190 | 140 | .70 | 6640 | | .70 | 11250 | | .70 | 16900 | | .70 | 23,240 | | .70 | 29,640 | |
| .80 | 910 | 90 | .80 | 3330 | 140 | .80 | 6840 | | .80 | 11500 | | .80 | 17200 | | .80 | 23,560 | | .80 | 29,960 | |
| .90 | 1000 | 100 | .90 | 3470 | 150 | .90 | 7040 | 200 | .90 | 11750 | 250 | .90 | 17500 | 300 | .90 | 23,880 | 320 | .90 | 30,280 | 320 |

This table is applicable for open-channel conditions. It is based on ________ discharge measurements made during ________ ________ and is ________ well defined between ________ cfs and ________ cfs.

Comp. by ______ date ______

Ckd. by ______ date ______

U.S. GOVERNMENT PRINTING OFFICE : 1967 O—300-785

PLATE G-31a

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 0 1 _ 7 0 5 0 0
Table No. 2 0
Begin 6 6 1 0 0 1 _ _ (YR. MO. D. HR.)

*Rating table for* Connecticut River at Montague City, Mass.
*from* October 1, 1966, *from* ______ *to* ______, *from* ______ *to* ______

| Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs |
| 17.00 | 30600 | 360 | 19.00 | 39000 | 380 | 21.00 | 46800 | 400 | 23.00 | 55000 | 440 | 25.00 | 64000 | 480 | 27.00 | 73800 | 520 | 29.00 | 84200 | 540 |
| .10 | 30960 | 360 | .10 | 39380 | 380 | .10 | 47200 | 400 | .10 | 55440 | 440 | .10 | 64480 | 480 | .10 | 74320 | 520 | .10 | 84740 | 540 |
| .20 | 31320 | 360 | .20 | 39760 | 380 | .20 | 47600 | 400 | .20 | 55880 | 440 | .20 | 64960 | 480 | .20 | 74840 | 520 | .20 | 85280 | 540 |
| .30 | 31680 | 360 | .30 | 40140 | 380 | .30 | 48000 | 400 | .30 | 56320 | 440 | .30 | 65440 | 480 | .30 | 75360 | 520 | .30 | 85820 | 540 |
| .40 | 32040 | 360 | .40 | 40520 | 380 | .40 | 48400 | 400 | .40 | 56760 | 440 | .40 | 65920 | 480 | .40 | 75880 | 520 | .40 | 86360 | 540 |
| .50 | 32400 | 360 | .50 | 40900 | 380 | .50 | 48800 | 400 | .50 | 57200 | 440 | .50 | 66400 | 480 | .50 | 76400 | 520 | .50 | 86900 | 540 |
| .60 | 32760 | 360 | .60 | 41280 | 380 | .60 | 49200 | 400 | .60 | 57640 | 440 | .60 | 66880 | 480 | .60 | 76920 | 520 | .60 | 87440 | 540 |
| .70 | 33120 | 360 | .70 | 41660 | 380 | .70 | 49600 | 400 | .70 | 58080 | 440 | .70 | 67360 | 480 | .70 | 77440 | 520 | .70 | 87980 | 540 |
| .80 | 33480 | 360 | .80 | 42040 | 380 | .80 | 50000 | 400 | .80 | 58520 | 440 | .80 | 67840 | 480 | .80 | 77960 | 520 | .80 | 88520 | 540 |
| .90 | 33840 | 360 | .90 | 42420 | 380 | .90 | 50400 | 400 | .90 | 59660 | 440 | .90 | 68320 | 480 | .90 | 78480 | 520 | .90 | 89060 | 540 |
| 18.00 | 35200 | 380 | 20.00 | 42800 | 400 | 22.00 | 50800 | 420 | 24.00 | 59400 | 460 | 26.00 | 68800 | 500 | 28.00 | 79000 | 520 | 30.00 | 89600 | 540 |
| .10 | 35580 | 380 | .10 | 43200 | 400 | .10 | 51220 | 420 | .10 | 59860 | 460 | .10 | 69300 | 500 | .10 | 79520 | 520 | .10 | 90140 | 540 |
| .20 | 35960 | 380 | .20 | 43600 | 400 | .20 | 51640 | 420 | .20 | 60320 | 460 | .20 | 69800 | 500 | .20 | 80040 | 520 | .20 | 90680 | 540 |
| .30 | 36340 | 380 | .30 | 44000 | 400 | .30 | 52060 | 420 | .30 | 60780 | 460 | .30 | 70300 | 500 | .30 | 80560 | 520 | .30 | 91220 | 540 |
| .40 | 36720 | 380 | .40 | 44400 | 400 | .40 | 52480 | 420 | .40 | 61240 | 460 | .40 | 70800 | 500 | .40 | 81080 | 520 | .40 | 91760 | 540 |
| .50 | 37100 | 380 | .50 | 44800 | 400 | .50 | 52900 | 420 | .50 | 61700 | 460 | .50 | 71300 | 500 | .50 | 81600 | 520 | .50 | 92300 | 540 |
| .60 | 37480 | 380 | .60 | 45200 | 400 | .60 | 53320 | 420 | .60 | 62160 | 460 | .60 | 71800 | 500 | .60 | 82120 | 520 | .60 | 92840 | 540 |
| .70 | 37860 | 380 | .70 | 45600 | 400 | .70 | 53740 | 420 | .70 | 62620 | 460 | .70 | 72300 | 500 | .70 | 82640 | 520 | .70 | 93380 | 540 |
| .80 | 38240 | 380 | .80 | 46000 | 400 | .80 | 54160 | 420 | .80 | 63080 | 460 | .80 | 72800 | 500 | .80 | 83160 | 520 | .80 | 93920 | 540 |
| .90 | 38620 | 380 | .90 | 46400 | 400 | .90 | 54580 | 420 | .90 | 63540 | 460 | .90 | 73300 | 500 | .90 | 83680 | 520 | .90 | 94460 | 540 |

This table is applicable for open-channel conditions. It is based on ______ discharge measurements made during ______
It is identical with rating 19 above and is ______ well defined between 5,000 cfs and 150,000 cfs.
6.0 feet

Comp. by RAG date 12-8-70
Ckd. by JWB date 12-17-70

PLATE G-31b

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—249-765

9-210
(Rev. 2-67)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Sta. No. 011 6500
Table No. 20
Begin 35 10 01 (YR. MO. D. HR.)

*Rating table for* Connecticut River at Montague City, Mass.
*from* October 1, 1935 *to* ____, *from* ____ *to* ____, *from* ____ *to* ____

| Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs |
| 31.00 | 95000 | 550 | 33.00 | 106500 | 650 | 35.00 | 120000 | 700 | 37.00 | 134000 | 700 | 39.00 | 149000 | 800 | 41.00 | 165000 | 800 | 43.00 | 181000 | 800 |
| .10 | 95550 | 550 | .10 | 107150 | 650 | .10 | 120700 | 700 | .10 | 134700 | 700 | .10 | 149800 | 800 | .10 | 165800 | 800 | .10 | 181800 | 800 |
| .20 | 96100 | 550 | .20 | 107800 | 650 | .20 | 121400 | 700 | .20 | 135400 | 700 | .20 | 150600 | 800 | .20 | 166600 | 800 | .20 | 182600 | 800 |
| .30 | 96650 | 550 | .30 | 108450 | 650 | .30 | 122100 | 700 | .30 | 136100 | 700 | .30 | 151400 | 800 | .30 | 167400 | 800 | .30 | 183400 | 800 |
| .40 | 97200 | 550 | .40 | 109100 | 650 | .40 | 122800 | 700 | .40 | 136800 | 700 | .40 | 152200 | 800 | .40 | 168200 | 800 | .40 | 184200 | 800 |
| .50 | 97750 | 550 | .50 | 109750 | 650 | .50 | 123500 | 700 | .50 | 137500 | 700 | .50 | 153000 | 800 | .50 | 169000 | 800 | .50 | 185000 | 800 |
| .60 | 98300 | 550 | .60 | 110400 | 650 | .60 | 124200 | 700 | .60 | 138200 | 700 | .60 | 153800 | 800 | .60 | 169800 | 800 | .60 | 185800 | 800 |
| .70 | 98850 | 550 | .70 | 111050 | 650 | .70 | 124900 | 700 | .70 | 138900 | 700 | .70 | 154600 | 800 | .70 | 170600 | 800 | .70 | 186600 | 800 |
| .80 | 99400 | 550 | .80 | 111700 | 650 | .80 | 125600 | 700 | .80 | 139600 | 700 | .80 | 155400 | 800 | .80 | 171400 | 800 | .80 | 187400 | 800 |
| .90 | 99950 | 550 | .90 | 112350 | 650 | .90 | 126300 | 700 | .90 | 140300 | 700 | .90 | 156200 | 800 | .90 | 172200 | 800 | .90 | 188200 | 800 |
| 32.00 | 100500 | 600 | 34.00 | 113000 | 700 | 36.00 | 127000 | 700 | 38.00 | 141000 | 800 | 40.00 | 157000 | 800 | 42.00 | 173000 | 800 | 44.00 | 189000 | 800 |
| .10 | 101100 | 600 | .10 | 113700 | 700 | .10 | 127700 | 700 | .10 | 141800 | 800 | .10 | 157800 | 800 | .10 | 173800 | 800 | .10 | 189800 | 800 |
| .20 | 101700 | 600 | .20 | 114400 | 700 | .20 | 128400 | 700 | .20 | 142600 | 800 | .20 | 158600 | 800 | .20 | 174600 | 800 | .20 | 190600 | 800 |
| .30 | 102300 | 600 | .30 | 115100 | 700 | .30 | 129100 | 700 | .30 | 143400 | 800 | .30 | 159400 | 800 | .30 | 175400 | 800 | .30 | 191400 | 800 |
| .40 | 102900 | 600 | .40 | 11580 | 700 | .40 | 129800 | 700 | .40 | 144200 | 800 | .40 | 160200 | 800 | .40 | 176200 | 800 | .40 | 192200 | 800 |
| .50 | 103500 | 600 | .50 | 116500 | 700 | .50 | 130500 | 700 | .50 | 145000 | 800 | .50 | 161000 | 800 | .50 | 177000 | 800 | .50 | 193000 | 800 |
| .60 | 104100 | 600 | .60 | 117200 | 700 | .60 | 131200 | 700 | .60 | 145800 | 800 | .60 | 161800 | 800 | .60 | 177800 | 800 | .60 | 193800 | 800 |
| .70 | 104700 | 600 | .70 | 117900 | 700 | .70 | 131900 | 700 | .70 | 146600 | 800 | .70 | 162600 | 800 | .70 | 178600 | 800 | .70 | 194600 | 800 |
| .80 | 105300 | 600 | .80 | 118600 | 700 | .80 | 132600 | 700 | .80 | 147400 | 800 | .80 | 163400 | 800 | .80 | 179400 | 800 | .80 | 195400 | 800 |
| .90 | 105900 | 600 | .90 | 119300 | 700 | .90 | 133300 | 700 | .90 | 148200 | 800 | .90 | 164200 | 800 | .90 | 180200 | 800 | .90 | 196200 | 800 |

This table is applicable for open-channel conditions. It is based on ____ discharge measurements made during ____
It is identical with rating 19 above and is ____ well defined between 5,000 cfs and 150,000 cfs.
6.0 feet.

Comp. by RAG date 12-8-70
Ckd. by JWB date 12-17-70

PLATE G-31c

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—340-765

## CONNECTICUT RIVER
## RATING TABLES

| Gage (ft) | Holyoke, Mass. (1) (DA = 8,177 sq. mi.) Zero Datum 97.47 ft msl | Springfield, Mass. (2) (DA = 9,587 sq. mi.) Zero Datum 37.76 ft msl | Hartford, Conn. (3) (DA = 10,428 sq. mi.) Zero Datum 0.55 ft msl |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 4,000 | 1,500 | 2,000 |
| 2 | 9,000 | 3,000 | 4,000 |
| 3 | 16,000 | 6,000 | 6,500 |
| 4 | 24,000 | 11,000 | 9,500 |
| 5 | 35,000 | 16,000 | 12,500 |
| 6 | 46,000 | 22,000 | 15,800 |
| 7 | 60,000 | 28,000 | 19,600 |
| 8 | 74,000 | 35,000 | 23,400 |
| 9 | 90,000 | 42,000 | 27,600 |
| 10 | 105,000 | 50,000 | 32,000 |
| 11 | 124,000 | 58,000 | 37,000 |
| 12 | 143,000 | 66,000 | 42,000 |
| 13 | 162,000 | 74,000 | 47,000 |
| 14 | 182,000 | 82,000 | 53,000 |
| 15 | 203,000 | 94,000 | 59,500 |
| 16 | 226,000 | 104,000 | 66,000 |
| 17 | | 114,000 | 72,500 |
| 18 | | 126,000 | 80,000 |
| 19 | | 138,000 | 87,500 |
| 20 | | 151,000 | 95,000 |
| 21 | | 166,000 | 104,000 |
| 22 | | 180,000 | 113,500 |
| 23 | | 194,000 | 123,500 |
| 24 | | 210,000 | 133,500 |
| 25 | | 225,000 | 143,500 |
| 26 | | 240,000 | 153,500 |
| 27 | | 257,000 | 163,500 |
| 28 | | 274,000 | 173,700 |
| 29 | | | 184,000 |
| 30 | | | 194,500 |
| 31 | | | 205,000 |
| 32 | | | 215,500 |
| 33 | | | 226,000 |
| 34 | | | 237,000 |

(1) gage located at Holyoke Water Power Company Dam.
(2) gage located at York Street Pumping Station.
(3) gage located at Buckley Bridge.

Table No. 29

Begin 671001 — — — —
YR. MO. D HR.

*Rating table for* Connecticut River at Thompsonville, Conn.

*from* Oct. 1970 *to* ............, *from* ............ *to* ............, *from* ............ *to* ............

| Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs |
| 0 .00 | | | 2 .00 | 12800 | 1100 | 4 .00 | 43000 | 1800 | 6 .00 | 80000 | 1900 | 8 .00 | 118000 | 1900 | 10 .00 | 156000 | 1900 | 12 .00 | 194000 | 1900 |
| .10 | | | .10 | 13900 | 1100 | .10 | 44800 | | .10 | 81900 | | .10 | 119900 | | .10 | 157900 | | .10 | 195900 | |
| .20 | | | .20 | 15000 | 1100 | .20 | 46600 | | .20 | 83800 | | .20 | 121800 | | .20 | 159800 | | .20 | 197800 | |
| .30 | | | .30 | 16100 | 1200 | .30 | 48400 | | .30 | 85700 | | .30 | 123700 | | .30 | 161700 | | .30 | 199700 | |
| .40 | | | .40 | 17300 | 1200 | .40 | 50200 | | .40 | 87600 | | .40 | 125600 | | .40 | 163600 | | .40 | 201600 | |
| .50 | | | .50 | 18500 | 1300 | .50 | 52000 | | .50 | 89500 | | .50 | 127500 | | .50 | 165500 | | .50 | 203500 | |
| .60 | | | .60 | 19800 | 1300 | .60 | 53800 | | .60 | 91400 | | .60 | 129400 | | .60 | 167400 | | .60 | 205400 | |
| .70 | | | .70 | 21100 | 1400 | .70 | 55600 | | .70 | 93300 | | .70 | 131300 | | .70 | 169300 | | .70 | 207300 | |
| .80 | | | .80 | 22500 | 1400 | .80 | 57400 | | .80 | 95200 | | .80 | 133200 | | .80 | 171200 | | .80 | 209200 | |
| .90 | | | .90 | 23900 | 1500 | .90 | 59200 | 1800 | .90 | 97100 | | .90 | 135100 | | .90 | 173100 | | .90 | 211100 | |
| 1 .00 | | | 3 .00 | 25400 | 1600 | 5 .00 | 61000 | 1900 | 7 .00 | 99000 | | 9 .00 | 137000 | | 11 .00 | 175000 | | 13 .00 | 213000 | |
| .10 | | | .10 | 27000 | 1700 | .10 | 62900 | | .10 | 100900 | | .10 | 138900 | | .10 | 176900 | | .10 | 214900 | |
| .20 | | | .20 | 28700 | 1700 | .20 | 64800 | | .20 | 102800 | | .20 | 140800 | | .20 | 178800 | | .20 | 216800 | |
| .30 | 6420 | 780 | .30 | 30400 | 1800 | .30 | 66700 | | .30 | 104700 | | .30 | 142700 | | .30 | 180700 | | .30 | 218700 | |
| .40 | 7200 | 850 | .40 | 32200 | | .40 | 68600 | | .40 | 106600 | | .40 | 144600 | | .40 | 182600 | | .40 | 220600 | |
| .50 | 8050 | 900 | .50 | 34000 | | .50 | 70500 | | .50 | 108500 | | .50 | 146500 | | .50 | 184500 | | .50 | 222500 | |
| .60 | 8950 | 900 | .60 | 35800 | | .60 | 72400 | | .60 | 110400 | | .60 | 148400 | | .60 | 186400 | | .60 | 224400 | |
| .70 | 9850 | 950 | .70 | 37600 | | .70 | 74300 | | .70 | 112300 | | .70 | 150300 | | .70 | 188300 | | .70 | 226300 | |
| .80 | 10100 | 1000 | .80 | 39400 | | .80 | 76200 | | .80 | 114200 | | .80 | 152200 | | .80 | 190200 | | .80 | 228200 | |
| .90 | 11800 | 1000 | .90 | 41200 | 1800 | .90 | 78100 | 1900 | .90 | 116100 | 1900 | .90 | 154100 | 1900 | .90 | 192100 | 1900 | .90 | 230100 | 1900 |

PLATE G-330

This table is applicable for open-channel conditions. It is based on ........ discharge measurements made during ............................
............................ and is ............ well defined between ............ cfs and ............ cfs.

Comp. by ...... date ......
Ckd. by ...... date ......

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—245-763

(Rev. )

**Geological Survey (Water Resources Division)**

Sta. No. __ __ __ __ __ __ __

Table No. __ __

Begin __ __ __ __ (YR. MO. D. HR.)

*Rating table for* Connecticut River at Thompsonville, Connecticut

*from* ____ *to* ____, *from* ____ *to* ____, *from* ____ *to* ____

| Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs |
| 14.00 | 232000 | 1900 | 16.00 | 271000 | 2000 | .00 | | | .00 | | | .00 | | | .00 | | | .00 | | |
| .10 | 233900 | | .10 | 273000 | | .10 | | | .10 | | | .10 | | | .10 | | | .10 | | |
| .20 | 235800 | | .20 | 275000 | | .20 | | | .20 | | | .20 | | | .20 | | | .20 | | |
| .30 | 237700 | | .30 | 277000 | | .30 | | | .30 | | | .30 | | | .30 | | | .30 | | |
| .40 | 249600 | | .40 | 279000 | | .40 | | | .40 | | | .40 | | | .40 | | | .40 | | |
| .50 | 241500 | | .50 | 281000 | | .50 | | | .50 | | | .50 | | | .50 | | | .50 | | |
| .60 | 243400 | | .60 | 283000 | 2000 | .60 | | | .60 | | | .60 | | | .60 | | | .60 | | |
| .70 | 245300 | | .70 | | | .70 | | | .70 | | | .70 | | | .70 | | | .70 | | |
| .80 | 247200 | | .80 | | | .80 | | | .80 | | | .80 | | | .80 | | | .80 | | |
| .90 | 249100 | 1900 | .90 | | | .90 | | | .90 | | | .90 | | | .90 | | | .90 | | |
| 15.00 | 251000 | 2000 | .00 | | | .00 | | | .00 | | | .00 | | | .00 | | | .00 | | |
| .10 | 253000 | | .10 | | | .10 | | | .10 | | | .10 | | | .10 | | | .10 | | |
| .20 | 255000 | | .20 | | | .20 | | | .20 | | | .20 | | | .20 | | | .20 | | |
| .30 | 257000 | | .30 | | | .30 | | | .30 | | | .30 | | | .30 | | | .30 | | |
| .40 | 259000 | | .40 | | | .40 | | | .40 | | | .40 | | | .40 | | | .40 | | |
| .50 | 261000 | | .50 | | | .50 | | | .50 | | | .50 | | | .50 | | | .50 | | |
| .60 | 263000 | | .60 | | | .60 | | | .60 | | | .60 | | | .60 | | | .60 | | |
| .70 | 265000 | | .70 | | | .70 | | | .70 | | | .70 | | | .70 | | | .70 | | |
| .80 | 267000 | | .80 | | | .80 | | | .80 | | | .80 | | | .80 | | | .80 | | |
| .90 | 269000 | 2000 | .90 | | | .90 | | | .90 | | | .90 | | | .90 | | | .90 | | |

This table is applicable for open-channel conditions. It is based on ____ discharge measurements made during ____ and is ____ well defined between ____ cfs and ____ cfs.

Comp. by ____ date ____

Ckd. by ____ date ____

PLATE G-33b

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—869-763

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

Table No. __

Begin ___ YR. ___ MO. ___ D. ___ HR.

*Rating table for* Chicopee River at Indian Orchard

*from* ________ *to* ________, *from* ________ *to* ________, *from* ________ *to* ________

| Gage height | Discharge | Differ-ence | Gage height | Discharge | Differ-ence | Gage height | Discharge | Differ-ence | Gage height | Discharge | Differ-ence | Gage height | Discharge | Differ-ence | Gage height | Discharge | Differ-ence | Gage height | Discharge | Differ-ence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* |
| 1 .00 | | | 3 .00 | 27 | 8 | 5 .00 | 660 | 65 | 7 .00 | 2350 | 100 | 9 .00 | 4720 | 140 | 11 .00 | 7810 | 180 | 13 .00 | 11890 | 240 |
| .10 | | | .10 | 35 | 9 | .10 | 725 | 70 | .10 | 2450 | 100 | .10 | 4860 | 140 | .10 | 7990 | 180 | .10 | 12130 | 240 |
| .20 | | | .20 | 44 | 11 | .20 | 795 | 70 | .20 | 2550 | 110 | .20 | 5000 | 140 | .20 | 8170 | 180 | .20 | 12370 | 240 |
| .30 | | | .30 | 55 | 13 | .30 | 865 | 70 | .30 | 2660 | 110 | .30 | 5140 | 140 | .30 | 8350 | 190 | .30 | 12610 | 240 |
| .40 | | | .40 | 68 | 14 | .40 | 935 | 70 | .40 | 2770 | 110 | .40 | 5280 | 140 | .40 | 8540 | 190 | .40 | 12850 | 250 |
| .50 | | | .50 | 82 | 16 | .50 | 1005 | 70 | .50 | 2880 | 110 | .50 | 5420 | 140 | .50 | 8730 | 190 | .50 | 13100 | 250 |
| .60 | | | .60 | 98 | 18 | .60 | 1080 | 80 | .60 | 2990 | 110 | .60 | 5560 | 150 | .60 | 8920 | 190 | .60 | 13350 | 250 |
| .70 | | | .70 | 116 | 21 | .70 | 1160 | 80 | .70 | 3100 | 110 | .70 | 5710 | 150 | .70 | 9110 | 200 | .70 | 13600 | 250 |
| .80 | | | .80 | 137 | 24 | .80 | 1240 | 80 | .80 | 3210 | 120 | .80 | 5860 | 150 | .80 | 9310 | 200 | .80 | 13850 | 250 |
| .90 | | | .90 | 161 | 27 | .90 | 1320 | 90 | .90 | 3330 | 120 | .90 | 6010 | 150 | .90 | 9510 | 200 | .90 | 14100 | 260 |
| 2 .00 | | | 4 .00 | 188 | 31 | 6 .00 | 1410 | 90 | 8 .00 | 3450 | 120 | 10 .00 | 6160 | 150 | 12 .00 | 9710 | 200 | 14 .00 | 14360 | 260 |
| .10 | | | .10 | 219 | 34 | .10 | 1500 | 90 | .10 | 3570 | 120 | .10 | 6310 | 160 | .10 | 9910 | 210 | .10 | 14620 | 260 |
| .20 | | | .20 | 253 | 37 | .20 | 1590 | 90 | .20 | 3690 | 120 | .20 | 6470 | 160 | .20 | 10120 | 210 | .20 | 14880 | 260 |
| .30 | | | .30 | 290 | 40 | .30 | 1680 | 90 | .30 | 3810 | 130 | .30 | 6630 | 160 | .30 | 10330 | 210 | .30 | 15140 | 270 |
| .40 | | | .40 | 330 | 45 | .40 | 1770 | 90 | .40 | 3940 | 130 | .40 | 6790 | 160 | .40 | 10540 | 220 | .40 | 15410 | 270 |
| .50 | | | .50 | 375 | 50 | .50 | 1860 | 90 | .50 | 4070 | 130 | .50 | 6950 | 170 | .50 | 10760 | 220 | .50 | 15680 | 270 |
| .60 | | | .60 | 425 | 55 | .60 | 1950 | 100 | .60 | 4200 | 130 | .60 | 7120 | 170 | .60 | 10980 | 220 | .60 | 15950 | 270 |
| .70 | 10.5 | 4.5 | .70 | 480 | 55 | .70 | 2050 | 100 | .70 | 4330 | 130 | .70 | 7290 | 170 | .70 | 11200 | 230 | .70 | 16220 | 270 |
| .80 | 15 | 5.5 | .80 | 535 | 60 | .80 | 2150 | 100 | .80 | 4460 | 130 | .80 | 7460 | 170 | .80 | 11430 | 230 | .80 | 16490 | 280 |
| .90 | 20.5 | 6.5 | .90 | 595 | 65 | .90 | 2250 | 100 | .90 | 4590 | 130 | .90 | 7630 | 180 | .90 | 11660 | 230 | .90 | 16770 | 280 |

PLATE G-340

This table is applicable for open-channel conditions. It is based on ________ discharge measurements made during ________________ and is ________ well defined between ________ cfs and ________ cfs.

Comp. by ______ date ______

Ckd. by ______ date ______

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—249-765

Table No. 1

Begin ___ YR. ___ MO. ___ D. ___

*Rating table for* Chicopee River at Indian Orchard

*from* ________ *to* ________, *from* ________ *to* ________, *from* ________ *to* ________

| Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Diff enc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cfs* | *Feet* | *Cfs* | *Cf* |
| 15.00 | 17050 | 280 | 17.00 | 22950 | 320 | 19.00 | 29500 | 340 | 21.00 | 36400 | 360 | .00 | | | .00 | | | .00 | | |
| .10 | 17330 | 280 | .10 | 23270 | 320 | .10 | 29840 | 340 | .10 | 36760 | 360 | .10 | | | .10 | | | .10 | | |
| .20 | 17610 | 280 | .20 | 23590 | 320 | .20 | 30180 | 340 | .20 | 37120 | 360 | .20 | | | .20 | | | .20 | | |
| .30 | 17890 | 280 | .30 | 23910 | 320 | .30 | 30520 | 340 | .30 | 37480 | 360 | .30 | | | .30 | | | .30 | | |
| .40 | 18170 | 280 | .40 | 24230 | 320 | .40 | 30860 | 340 | .40 | 37840 | 360 | .40 | | | .40 | | | .40 | | |
| .50 | 18450 | 290 | .50 | 24550 | 330 | .50 | 31200 | 340 | .50 | 38200 | 360 | .50 | | | .50 | | | .50 | | |
| .60 | 18740 | 290 | .60 | 24880 | 330 | .60 | 31540 | 340 | .60 | 38560 | 360 | .60 | | | .60 | | | .60 | | |
| .70 | 19030 | 290 | .70 | 25210 | 330 | .70 | 31880 | 340 | .70 | 38920 | 360 | .70 | | | .70 | | | .70 | | |
| .80 | 19320 | 290 | .80 | 25540 | 330 | .80 | 32220 | 340 | .80 | 39280 | 360 | .80 | | | .80 | | | .80 | | |
| .90 | 19610 | 290 | .90 | 25870 | 330 | .90 | 32560 | 340 | .90 | 39640 | 360 | .90 | | | .90 | | | .90 | | |
| 16.00 | 19900 | 300 | 18.00 | 26200 | 330 | 20.00 | 32900 | 350 | 22.00 | 40000 | 360 | .00 | | | .00 | | | .00 | | |
| .10 | 20200 | 300 | .10 | 26530 | 330 | .10 | 33250 | 350 | .10 | 40360 | 360 | .10 | | | .10 | | | .10 | | |
| .20 | 20500 | 300 | .20 | 26860 | 330 | .20 | 33600 | 350 | .20 | 40720 | | .20 | | | .20 | | | .20 | | |
| .30 | 20800 | 300 | .30 | 27190 | 330 | .30 | 33950 | 350 | .30 | | | .30 | | | .30 | | | .30 | | |
| .40 | 21100 | 300 | .40 | 27520 | 330 | .40 | 34300 | 350 | .40 | | | .40 | | | .40 | | | .40 | | |
| .50 | 21400 | 310 | .50 | 27850 | 330 | .50 | 34750 | 350 | .50 | | | .50 | | | .50 | | | .50 | | |
| .60 | 21710 | 310 | .60 | 28180 | 330 | .60 | 35100 | 350 | .60 | | | .60 | | | .60 | | | .60 | | |
| .70 | 22020 | 310 | .70 | 28510 | 330 | .70 | 35450 | 350 | .70 | | | .70 | | | .70 | | | .70 | | |
| .80 | 22330 | 310 | .80 | 28840 | 330 | .80 | 35800 | 350 | .80 | | | .80 | | | .80 | | | .80 | | |
| .90 | 22740 | 320 | .90 | 29170 | 330 | .90 | 36150 | 350 | .90 | | | .90 | | | .90 | | | .90 | | |

This table is applicable for open-channel conditions. It is based on ______ discharge measurements made during ____________ and is ________ well defined between ________ cfs and ________ cfs.

Comp. by ______ date ______

Ckd. by ______ date ______

PLATE G-34b

U.S. GOVERNMENT PRINTING OFFICE : 1947 O?—249

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)

**Table No.** 25

**Begin** ___ ___ ___ ___
YR. MO. D. HR.

*Rating table for* Ware River at Barre

*from* ______ *to* ______, *from* ______ *to* ______, *from* ______ *to* ______

| Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference | Gage height | Discharge | Difference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs | Feet | Cfs | Cfs |
| 2.00 | | | 4.00 | 283 | 37 | 6.00 | 1592 | 108 | .00 | | | .00 | | | .00 | | | .00 | | |
| .10 | 1.3 | 1.4 | .10 | 320 | 37 | .10 | 1700 | 112 | .10 | | | .10 | | | .10 | | | .10 | | |
| .20 | 2.7 | 2.0 | .20 | 357 | 40 | .20 | 1812 | 117 | .20 | | | .20 | | | .20 | | | .20 | | |
| .30 | 4.7 | 2.9 | .30 | 397 | 43 | .30 | 1929 | 121 | .30 | | | .30 | | | .30 | | | .30 | | |
| .40 | 7.6 | 4.0 | .40 | 440 | 45 | .40 | 2050 | | .40 | | | .40 | | | .40 | | | .40 | | |
| .50 | 11.6 | 4.9 | .50 | 485 | 49 | .50 | | | .50 | | | .50 | | | .50 | | | .50 | | |
| .60 | 16.5 | 6.3 | .60 | 534 | 51 | .60 | | | .60 | | | .60 | | | .60 | | | .60 | | |
| .70 | 22.8 | 7.8 | .70 | 585 | 55 | .70 | | | .70 | | | .70 | | | .70 | | | .70 | | |
| .80 | 30.6 | 9.4 | .80 | 640 | 58 | .80 | | | .80 | | | .80 | | | .80 | | | .80 | | |
| .90 | 40.0 | 10.8 | .90 | 698 | 62 | .90 | | | .90 | | | .90 | | | .90 | | | .90 | | |
| 3.00 | 50.8 | 12.6 | 5.00 | 760 | 66 | .00 | | | .00 | | | .00 | | | .00 | | | .00 | | |
| .10 | 63.4 | 14.6 | .10 | 826 | 70 | .10 | | | .10 | | | .10 | | | .10 | | | .10 | | |
| .20 | 78.0 | 16.7 | .20 | 896 | 74 | .20 | | | .20 | | | .20 | | | .20 | | | .20 | | |
| .30 | 94.7 | 19.3 | .30 | 970 | 76 | .30 | | | .30 | | | .30 | | | .30 | | | .30 | | |
| .40 | 114 | 21 | .40 | 1046 | 79 | .40 | | | .40 | | | .40 | | | .40 | | | .40 | | |
| .50 | 135 | 24 | .50 | 1125 | 84 | .50 | | | .50 | | | .50 | | | .50 | | | .50 | | |
| .60 | 159 | 26 | .60 | 1209 | 89 | .60 | | | .60 | | | .60 | | | .60 | | | .60 | | |
| .70 | 185 | 29 | .70 | 1298 | 92 | .70 | | | .70 | | | .70 | | | .70 | | | .70 | | |
| .80 | 214 | 33 | .80 | 1390 | 99 | .80 | | | .80 | | | .80 | | | .80 | | | .80 | | |
| .90 | 247 | 36 | .90 | 1489 | 103 | .90 | | | .90 | | | .90 | | | .90 | | | .90 | | |

PLATE G-35

This table is applicable for open-channel conditions. It is based on ______ discharge measurements made during ______

______ and is ______ well defined between ______ cfs and ______ cfs.

Comp. by ______ date ______

Ckd. by ______ date ______

U.S. GOVERNMENT PRINTING OFFICE : 1967 OF—869-765

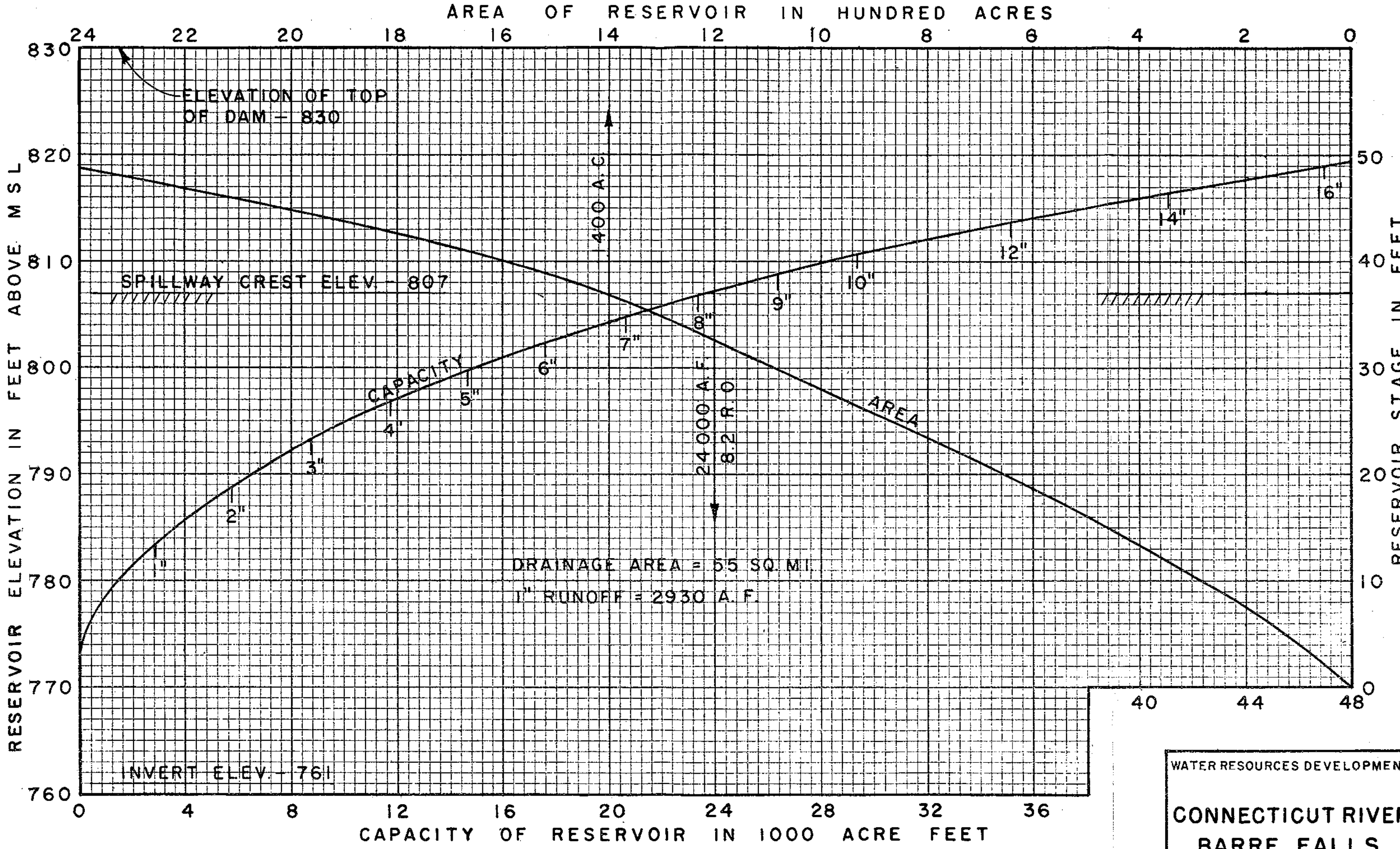
BARRE FALLS DAM
AREA AND CAPACITY

DRAINAGE AREA = 55 SQ.MI.

| Elev. (msl) | Stage (ft) | Area (acres) | Capacity Ac-Feet | Capacity Inches |
|---|---|---|---|---|
| 770 | 0 | 0 | 0 | 0.00 |
| 771 | 1 | 20 | 15 | .01 |
| 772 | 2 | 50 | 60 | .02 |
| 773 | 3 | 80 | 120 | .04 |
| 774 | 4 | 100 | 220 | .07 |
| 775 | 5 | 125 | 340 | .12 |
| 776 | 6 | 160 | 490 | .17 |
| 777 | 7 | 180 | 670 | .23 |
| 778 | 8 | 215 | 880 | .30 |
| 779 | 9 | 245 | 1120 | .38 |
| 780 | 10 | 280 | 1390 | .47 |
| 781 | 11 | 320 | 1700 | .58 |
| 782 | 12 | 360 | 2050 | .70 |
| 783 | 13 | 390 | 2430 | .83 |
| 784 | 14 | 430 | 2850 | .97 |
| 785 | 15 | 460 | 3300 | 1.12 |
| 786 | 16 | 500 | 3790 | 1.29 |
| 787 | 17 | 540 | 4320 | 1.47 |
| 788 | 18 | 580 | 4900 | 1.67 |
| 789 | 19 | 620 | 5510 | 1.88 |
| 790 | 20 | 660 | 6170 | 2.10 |
| 791 | 21 | 700 | 6870 | 2.34 |
| 792 | 22 | 740 | 7610 | 2.59 |
| 793 | 23 | 790 | 8410 | 2.86 |
| 794 | 24 | 830 | 9250 | 3.15 |
| 795 | 25 | 870 | 10100 | 3.44 |
| 796 | 26 | 920 | 11000 | 3.75 |
| 797 | 27 | 960 | 12000 | 4.09 |
| 798 | 28 | 1000 | 13000 | 4.46 |
| 799 | 29 | 1040 | 14100 | 4.80 |
| 800 | 30 | 1090 | 15200 | 5.18 |
| 801 | 31 | 1140 | 16300 | 5.55 |
| 802 | 32 | 1180 | 17500 | 5.96 |
| 803 | 33 | 1220 | 18700 | 6.37 |
| 804 | 34 | 1260 | 20000 | 6.81 |
| 805 | 35 | 1300 | 21300 | 7.26 |
| 806 | 36 | 1350 | 22600 | 7.70 |
| 807 | 37 | 1400 | 24000 | 8.20 |

Crest Elevation = 807

Invert Elevation = 761 due to
9 foot drop at inlet channel.



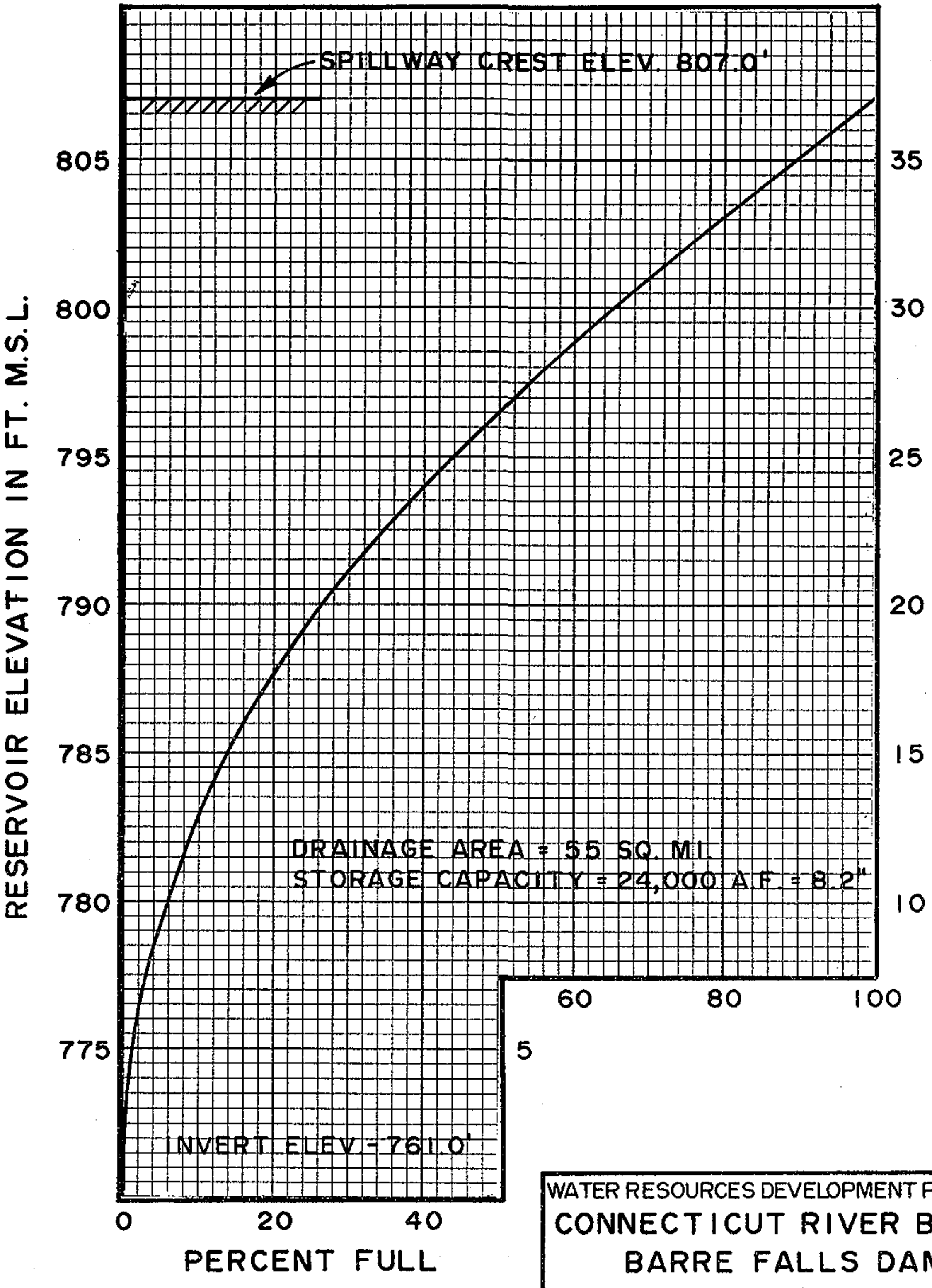

NOTE: INVERT ELEVATION = 761 DUE TO
9' DROP AT INLET CHANNEL.

WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
BARRE FALLS DAM
**AREA-CAPACITY CURVES**

NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978

PLATE G-37




NOTE: INVERT ELEV. = 761 DUE TO 9' DROP AT INLET CHANNEL.

WATER RESOURCES DEVELOPMENT PROJECT
CONNECTICUT RIVER BASIN
BARRE FALLS DAM
PERCENT STORAGE CURVE
NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978

PLATE G-38

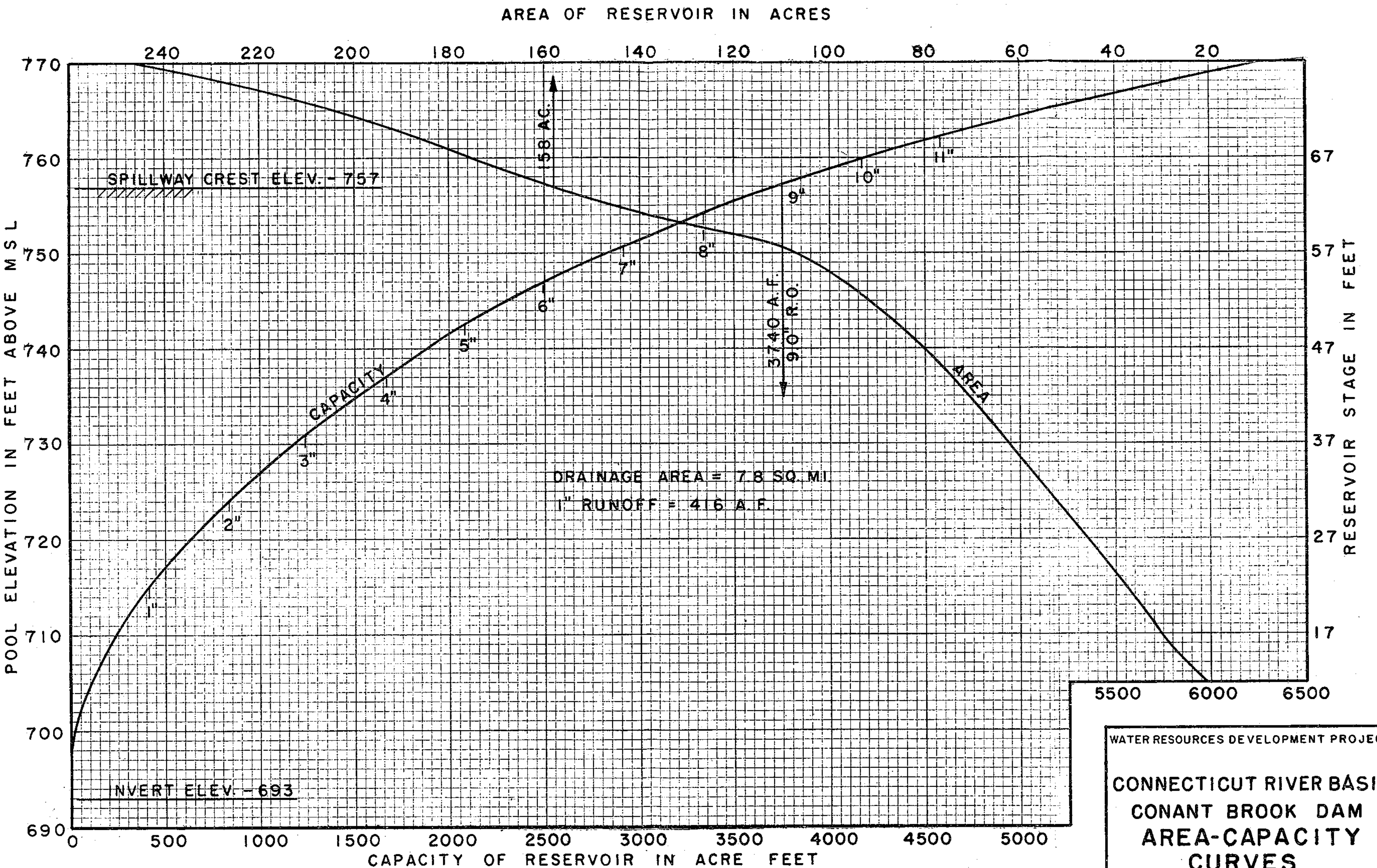
CONANT BROOK DAM
AREA AND CAPACITY

DRAINAGE AREA = 7.8 SQ.MI.

| ge<br>t) | Area<br>(acres) | Capacity<br>Acre-Ft. | Capacity<br>Inches |
|---|---|---|---|
| 0 | 0 | 0 | .00 |
| 1 | 1 | 1 | .00 |
| 2 | 2 | 4 | .01 |
| 3 | 3 | 8 | .02 |
| 4 | 4 | 12 | .03 |
| 5 | 5 | 16 | .04 |
| 6 | 6 | 20 | .05 |
| 7 | 8 | 24 | .06 |
| 8 | 11 | 28 | .07 |
| 9 | 15 | 40 | .10 |
| 0 | 17 | 60 | .14 |
| 1 | 19 | 80 | .19 |
| 2 | 21 | 100 | .24 |
| 3 | 23 | 125 | .30 |
| 4 | 25 | 150 | .36 |
| 5 | 27 | 180 | .43 |
| 6 | 29 | 210 | .50 |
| 7 | 31 | 240 | .58 |
| 8 | 32 | 270 | .65 |
| 9 | 34 | 310 | .74 |
| 0 | 35 | 345 | .83 |
| 1 | 36 | 380 | .91 |
| 2 | 38 | 415 | 1.00 |
| 3 | 40 | 450 | 1.08 |
| 4 | 41 | 490 | 1.18 |
| 5 | 43 | 530 | 1.27 |
| 6 | 44 | 570 | 1.37 |
| 7 | 46 | 620 | 1.49 |
| 8 | 48 | 675 | 1.62 |
| 9 | 50 | 730 | 1.75 |
| 0 | 51 | 785 | 1.89 |
| 1 | 52 | 840 | 2.02 |
| 2 | 54 | 895 | 2.15 |

| Elev.<br>(msl) | Stage<br>(ft) | Area<br>(acres) | Capacity<br>Acre-Ft. | Capacity<br>Inches |
|---|---|---|---|---|
| 726 | 33 | 56 | 950 | 2.28 |
| 727 | 34 | 58 | 1010 | 2.43 |
| 728 | 35 | 60 | 1070 | 2.57 |
| 729 | 36 | 62 | 1130 | 2.72 |
| 730 | 37 | 64 | 1190 | 2.86 |
| 731 | 38 | 65 | 1250 | 3.00 |
| 732 | 39 | 66 | 1310 | 3.15 |
| 733 | 40 | 68 | 1375 | 3.30 |
| 734 | 41 | 69 | 1440 | 3.46 |
| 735 | 42 | 71 | 1505 | 3.62 |
| 736 | 43 | 73 | 1575 | 3.79 |
| 737 | 44 | 75 | 1650 | 3.97 |
| 738 | 45 | 77 | 1720 | 4.13 |
| 739 | 46 | 79 | 1800 | 4.32 |
| 740 | 47 | 80 | 1875 | 4.51 |
| 741 | 48 | 83 | 1950 | 4.59 |
| 742 | 49 | 85 | 2030 | 4.89 |
| 743 | 50 | 87 | 2110 | 5.07 |
| 744 | 51 | 89 | 2200 | 5.29 |
| 745 | 52 | 92 | 2300 | 5.53 |
| 746 | 53 | 94 | 2400 | 5.77 |
| 747 | 54 | 97 | 2500 | 6.01 |
| 748 | 55 | 100 | 2600 | 6.25 |
| 749 | 56 | 104 | 2705 | 6.50 |
| 750 | 57 | 107 | 2815 | 6.77 |
| 751 | 58 | 112 | 2940 | 7.07 |
| 752 | 59 | 119 | 3065 | 7.37 |
| 753 | 60 | 130 | 3190 | 7.67 |
| 754 | 61 | 139 | 3320 | 7.98 |
| 755 | 62 | 146 | 3450 | 8.29 |
| 756 | 63 | 152 | 3580 | 8.61 |
| 757 | 64 | 158 | 3740 | 9.00 |

Crest Elevation = 757




WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN

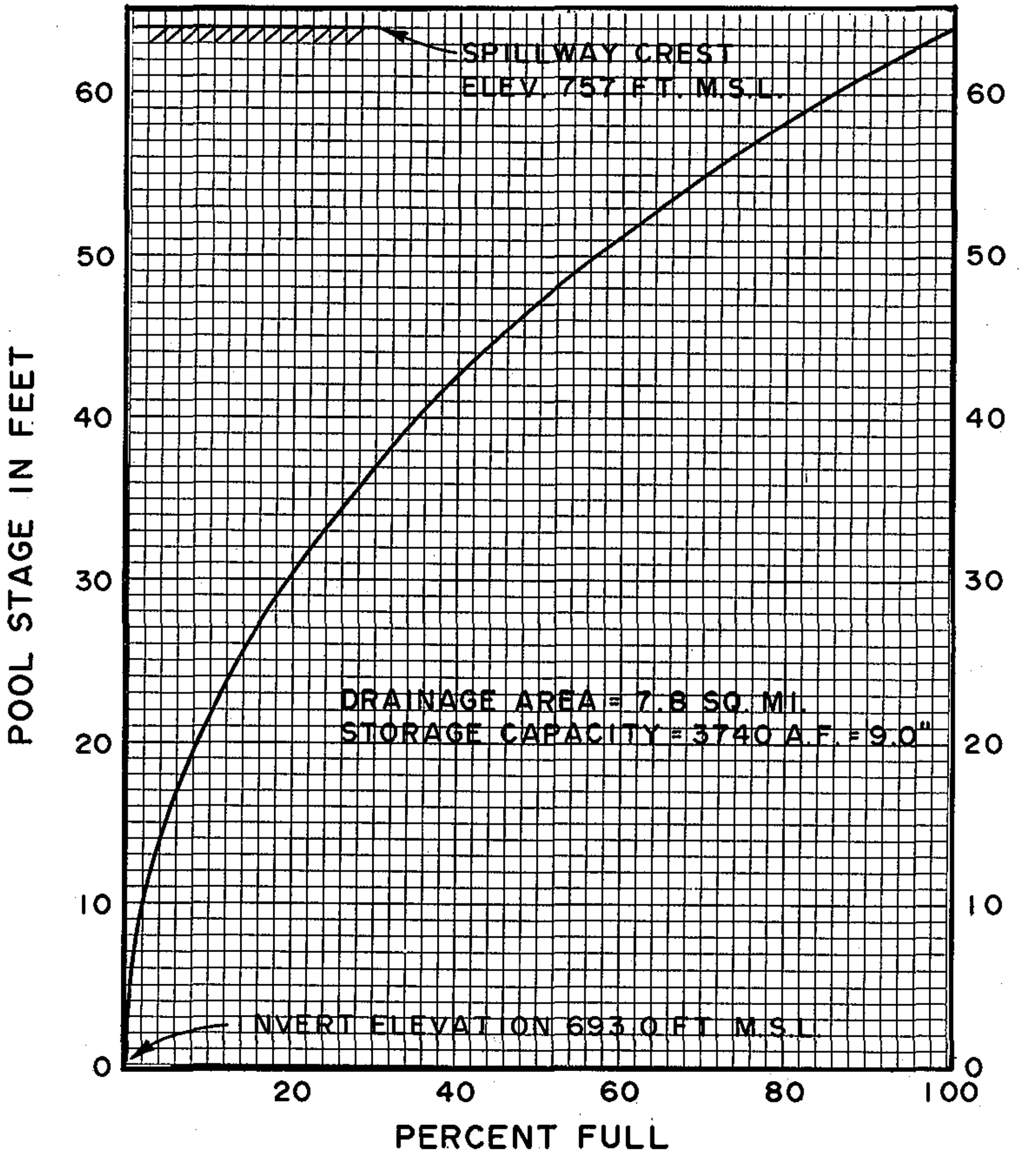
CONANT BROOK DAM

AREA-CAPACITY CURVES

NEW ENGLAND DIVISION, WALTHAM, MASS.

MAY 1978

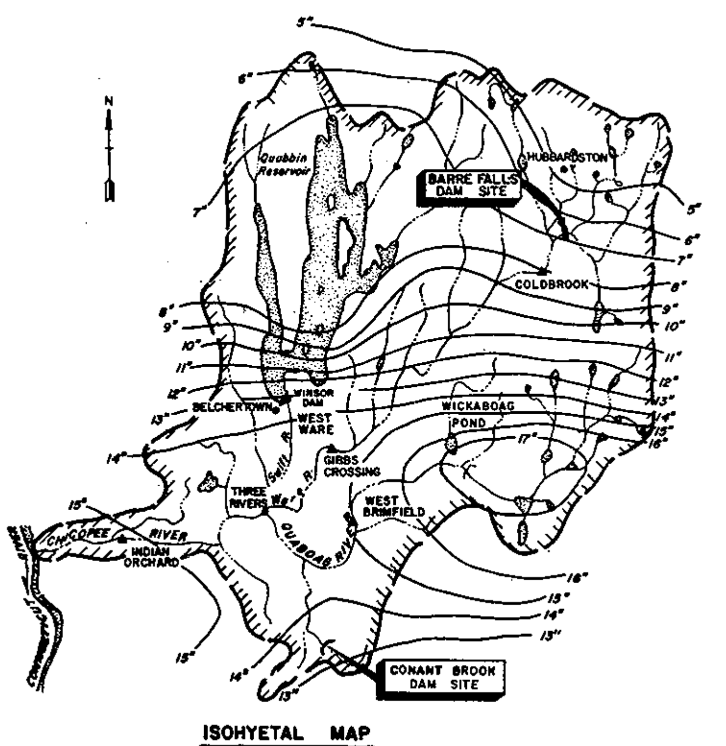
PLATE G-40




WATER RESOURCES DEVELOPMENT PROJECT
CONNECTICUT RIVER BASIN
CONANT BROOK DAM
PERCENT STORAGE CURVE
NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978

PLATE G-41

CORPS OF ENGINEERS U. S. ARMY

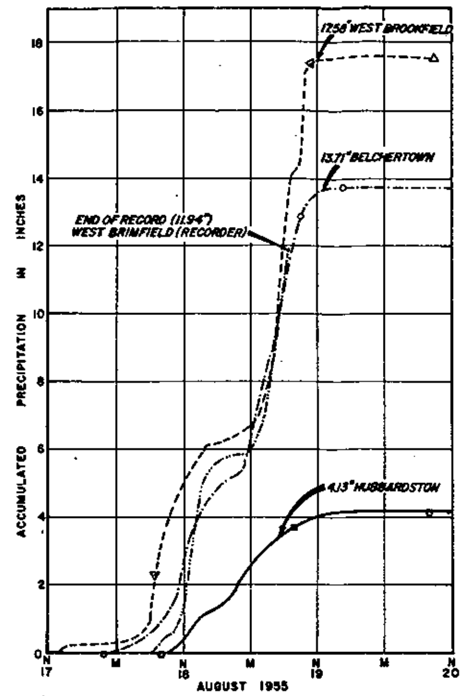



ISOHYETAL MAP

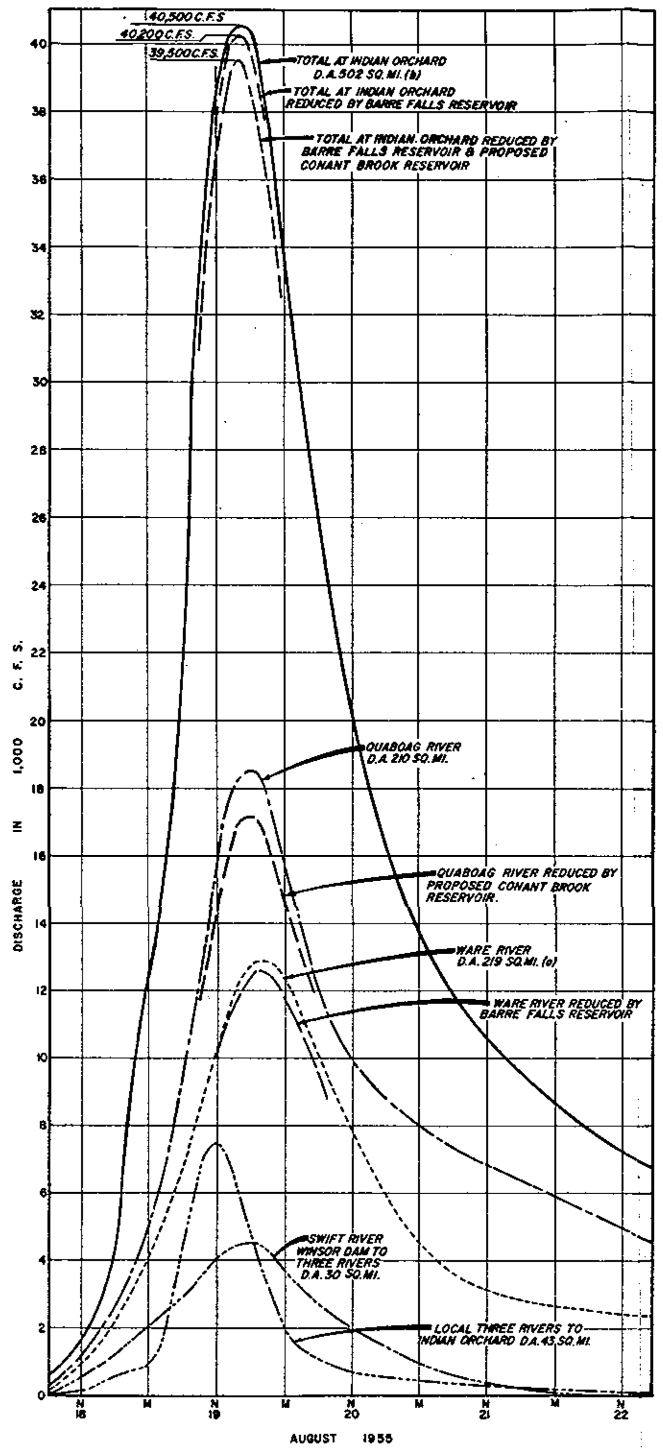
AUGUST 17-20 1955 STORM

CHICOPEE RIVER BASIN

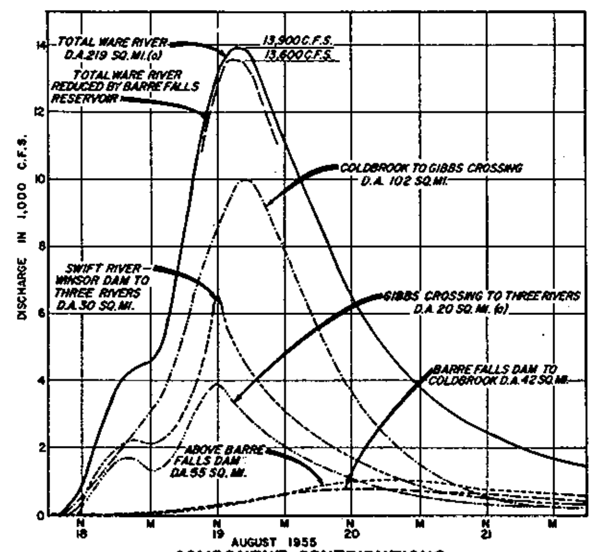
SCALE IN MILES



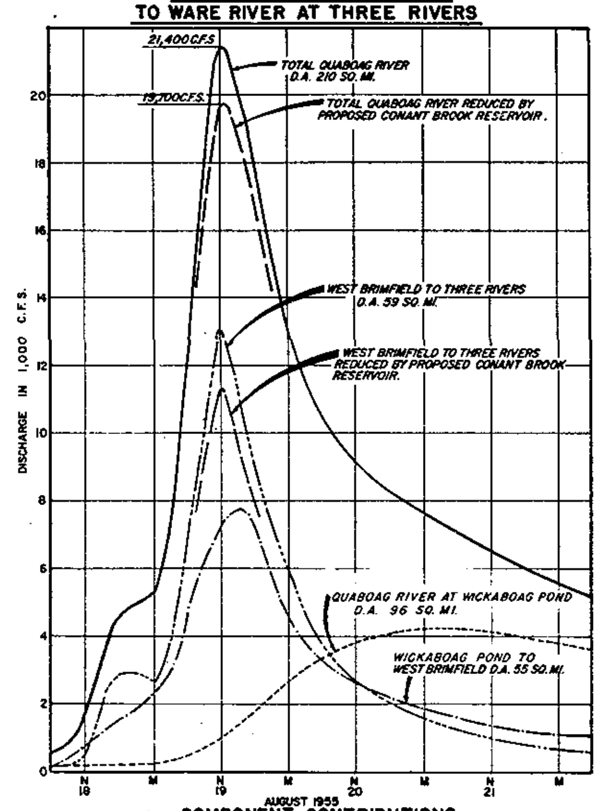

PRECIPITATION MASS CURVES



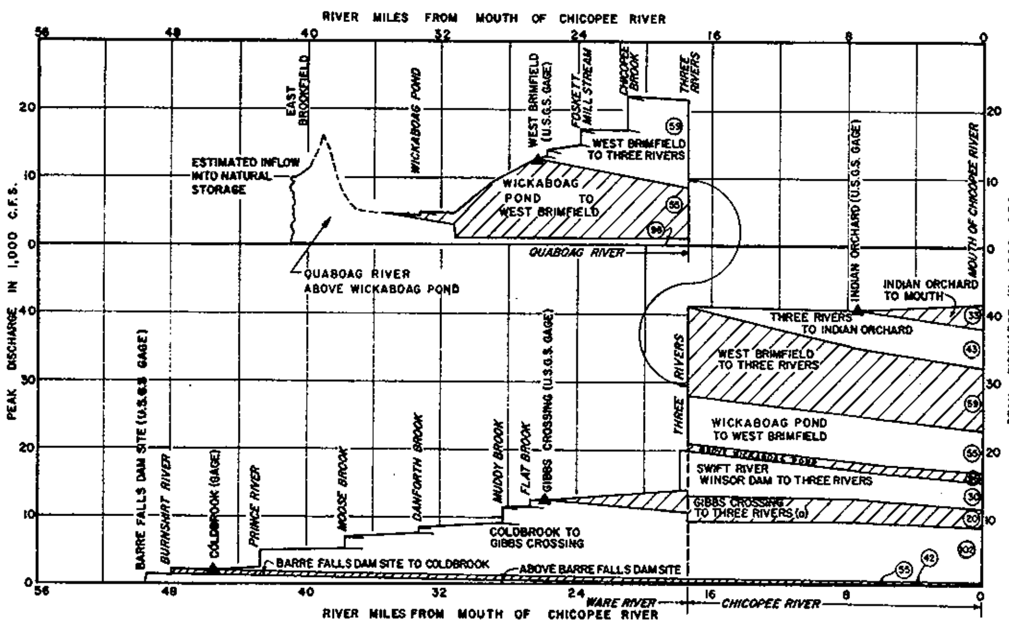

COMPONENT CONTRIBUTIONS TO CHICOPEE RIVER AT INDIAN ORCHARD




COMPONENT CONTRIBUTIONS TO WARE RIVER AT THREE RIVERS




COMPONENT CONTRIBUTIONS TO QUABOAG RIVER AT THREE RIVERS




NATURAL PEAK DISCHARGE PROFILE AND TRIBUTARY CONTRIBUTIONS

NOTES

▲ U.S.G.S. Gaging Station.

(55) Denotes drainage area in Sq. Mi. on profile

(a) Exclusive of Swift River.

(b) Exclusive of 186 Sq. Mi. on Swift River above Winsor Dam (Quabbin Reservoir)

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

| DR. BY | TR. BY | CK. BY |
|---|---|---|
| | M.W.B. | R.M. |

CONNECTICUT RIVER FLOOD CONTROL

CHICOPEE RIVER BASIN

AUGUST 1955 FLOOD

CHICOPEE RIVER, MASSACHUSETTS

DATE AUG 1959

SUBMITTED BY — APPROVED — APPROVED

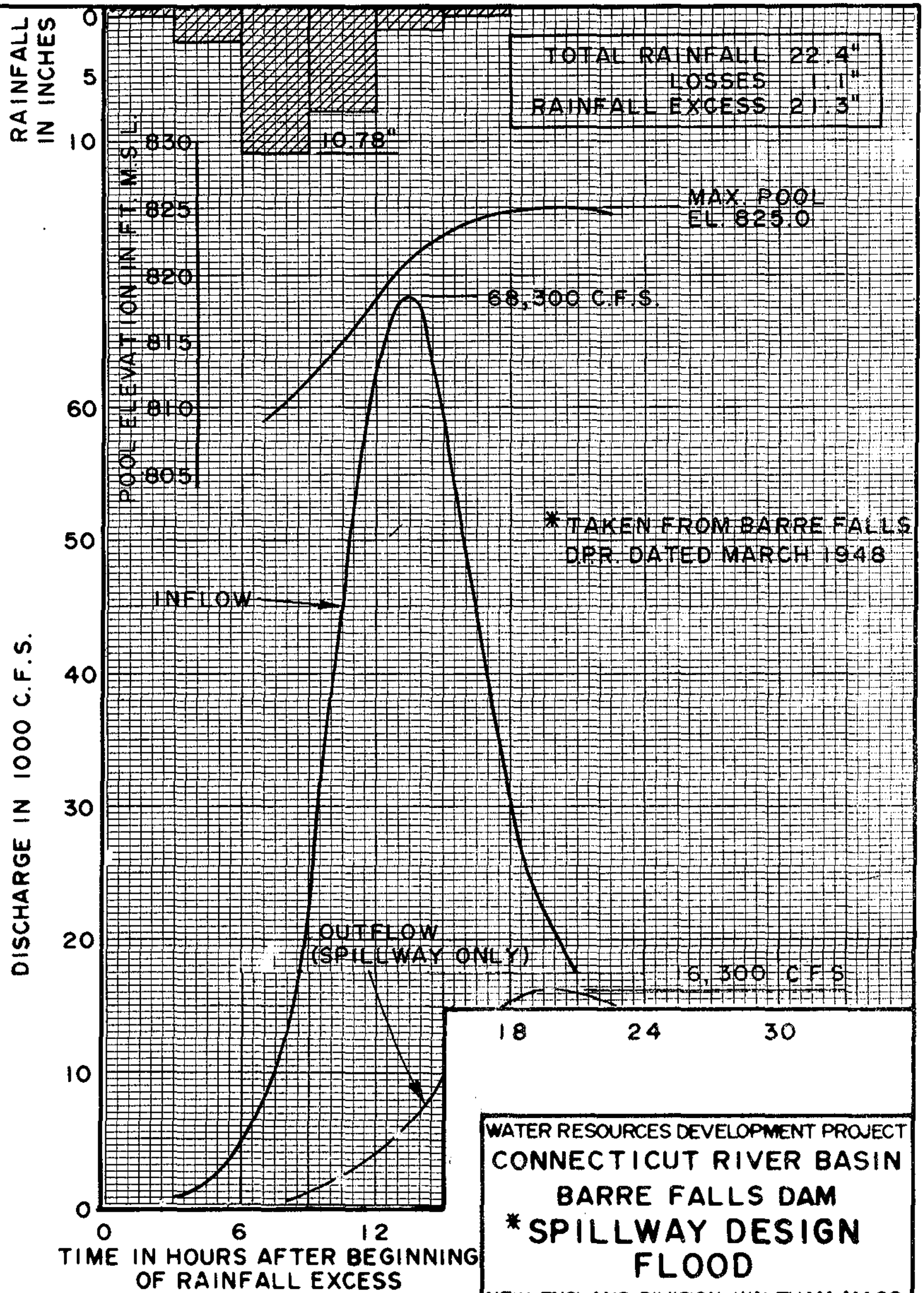
TO ACCOMPANY REPORT DATED: 8 SEPTEMBER 1959

SCALE AS SHOWN

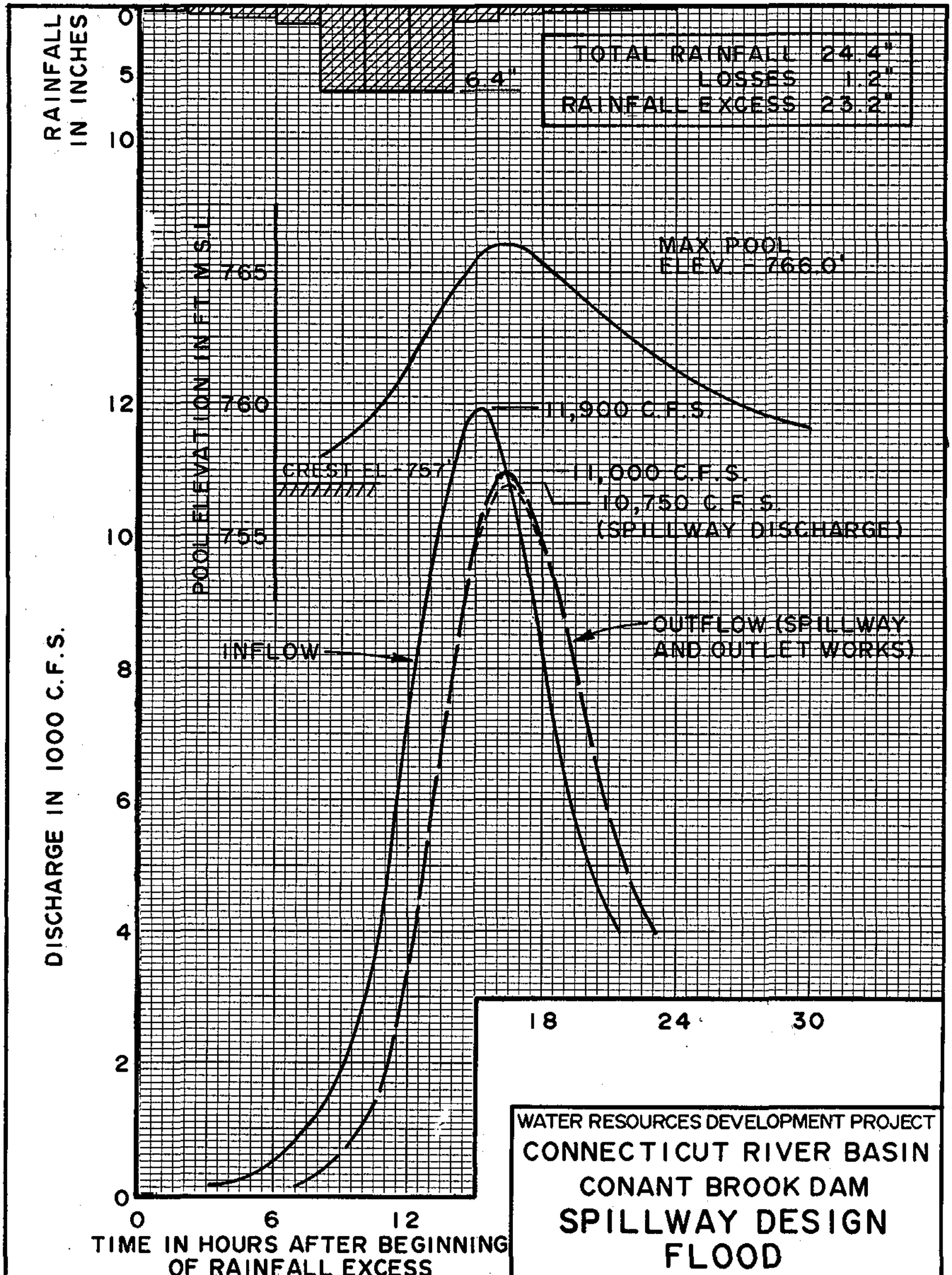
DRAWING NUMBER CT-1-5612

SHEET 1 OF 1

PLATE G-43




WATER RESOURCES DEVELOPMENT PROJECT
CONNECTICUT RIVER BASIN
BARRE FALLS DAM
*SPILLWAY DESIGN FLOOD
NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978



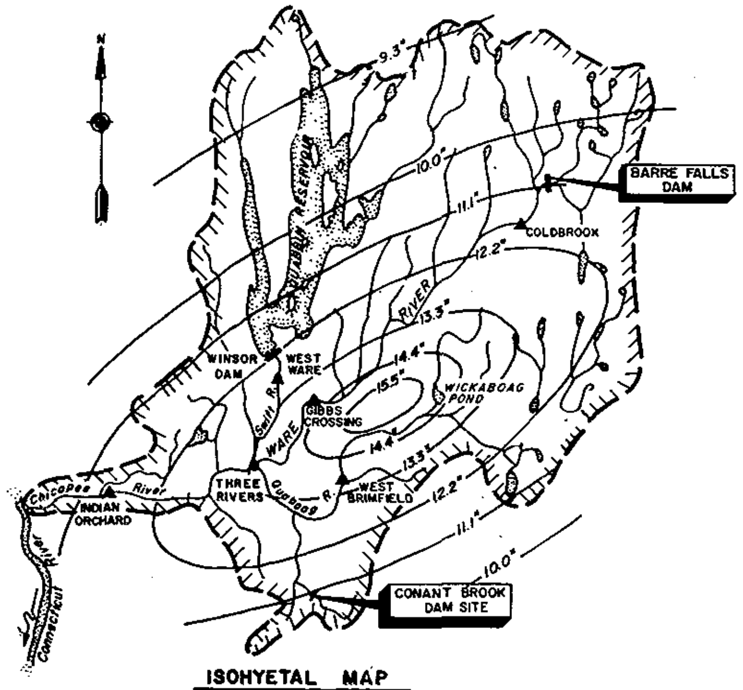

WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN

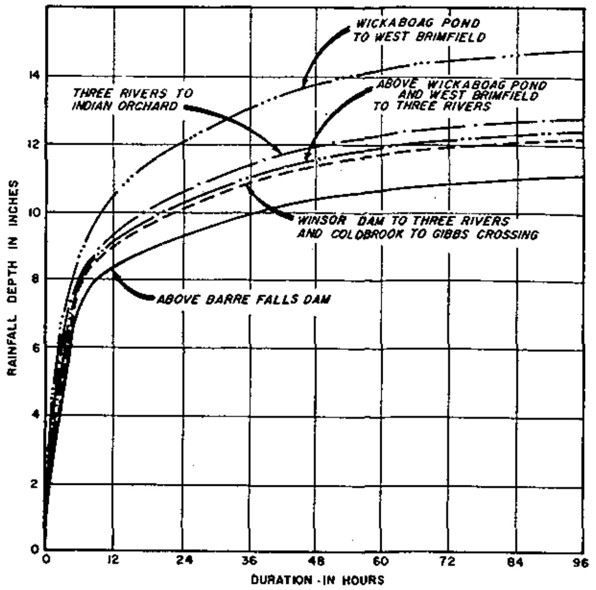
CONANT BROOK DAM

SPILLWAY DESIGN FLOOD

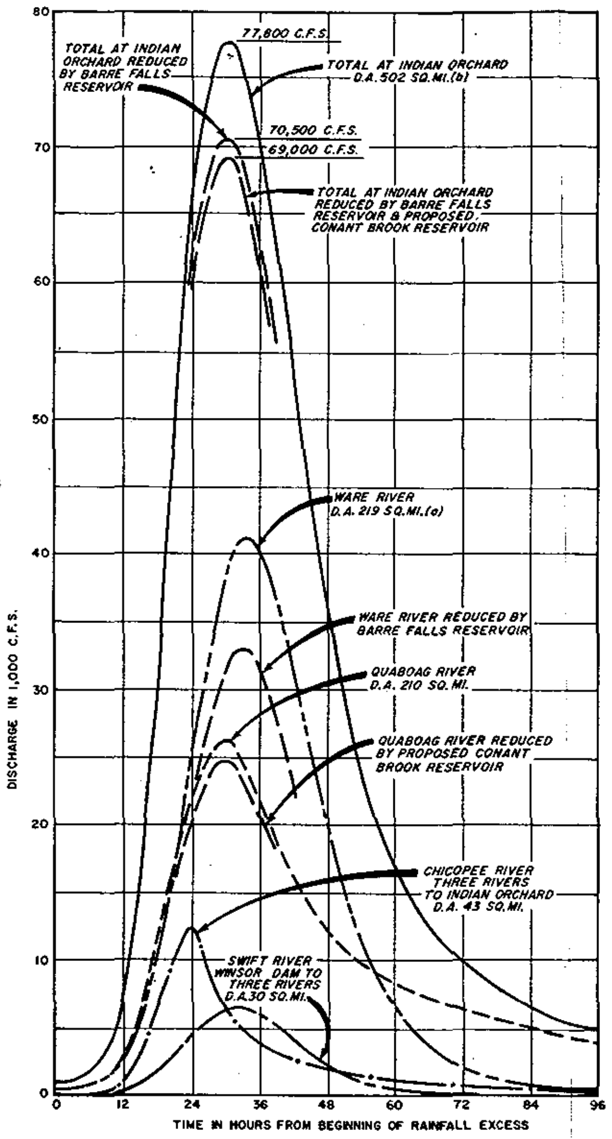
NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978



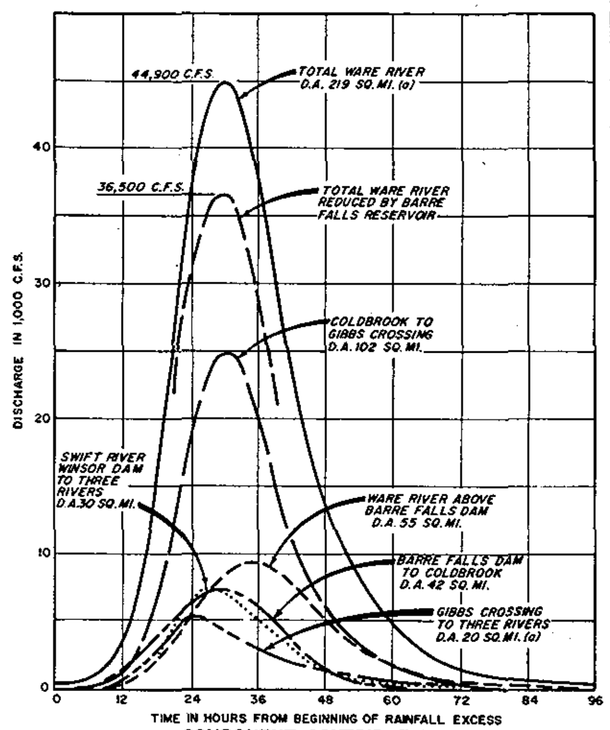

ISOHYETAL MAP
STANDARD PROJECT STORM
96-HOUR DURATION



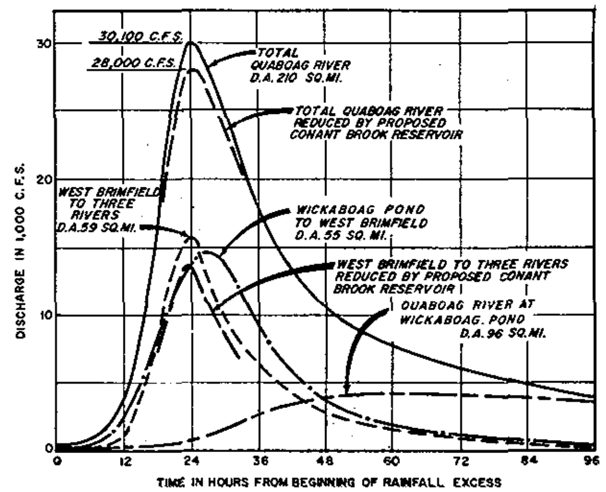

DEPTH DURATION CURVES



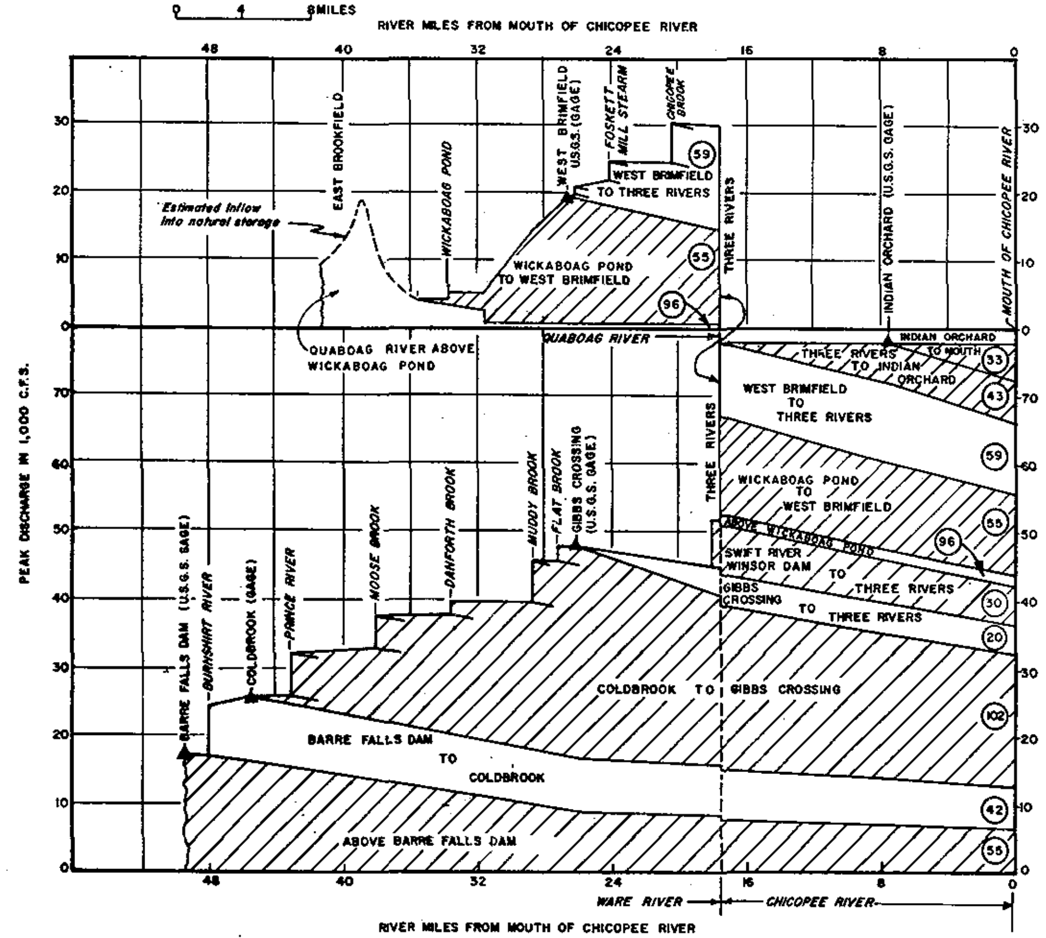

COMPONENT CONTRIBUTIONS TO CHICOPEE RIVER AT INDIAN ORCHARD




COMPONENT CONTRIBUTIONS TO WARE RIVER AT THREE RIVERS




COMPONENT CONTRIBUTIONS TO QUABOAG RIVER AT THREE RIVERS




NATURAL PEAK DISCHARGE PROFILE AND TRIBUTARY CONTRIBUTIONS

NOTES:
(55) Denotes drainage area in sq.mi. on profile
(a) Exclusive of Swift River
(b) Exclusive of 186 sq.mi on Swift River above Winsor Dam (Quabbin Reservoir)
▲ U.S.G.S. Gaging Station

| REVISION | DATE | DESCRIPTION | BY |
|---|---|---|---|

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY | TR. BY S.J.C. | CK. BY R.M.

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN
STANDARD PROJECT FLOOD
CHICOPEE RIVER, MASSACHUSETTS

CHIEF, HYD & HYD SECTION
SUBMITTED BY
CHIEF, PLANNING BRANCH
APPROVED
CHIEF, ENGINEERING DIV.
APPROVED
COL. C.E. DEPUTY DIVISION ENGINEER
DATE AUG. 1959

TO ACCOMPANY REPORT
DATED: 8 SEPTEMBER 1959

SCALE AS SHOWN
DRAWING NUMBER CT-1-5616
SHEET 1 OF 1

ALL STATION SCAN 2 FEB. 1973

| COASTAL STATION | FILE NO. | DAY HR.MIN. | TIDE | BAROMETER | WIND VELOCITY | WIND DIRECTION |
|---|---|---|---|---|---|---|
| 40 BLOCK ISLAND | 54 | 33 2055 | 2.80 FT. | 29.03 IN. WARN | 49 MPH | 225 DEGR |

| COASTAL STATION | FILE NO. | DAY HR.MIN. | TIDE | BAROMETER | WIND VELOCITY | WIND DIRECTION |
|---|---|---|---|---|---|---|
| 41 OLD SAYBROOK | 52 | 33 2055 | 2.50 FT. | 29.12 IN. WARN | 39 MPH | 149 DEGR |

98

| STA. NO. AND NAME | FILE NO. | DAY HR.MIN. | DISCH. | CFS/SM | STAGE | | CHNGSTG | RAIN | INCR. |
|---|---|---|---|---|---|---|---|---|---|
| 38 WELLS RIVER | 72 | 33 2055 | 7024. | 2.7 | 4.60 FT. | | 0.0 | | |
| 36 WEST HARTFORD | 72 | 33 2056 | 840. | 1.2 | 4.30 FT. | | -0.1 | | |
| 35 WHITE RIVER JUNCTION | 69 | 33 2056 | 11590. | 2.8 | 8.70 FT. | | -0.1 | | |
| 37 N WALPOLE | 72 | 33 2056 | 14850. | 2.7 | 10.90 FT. | | 0.0 | | |
| 15 KEENE | 72 | 33 2056 | 0. | 0.0 | 69.50 FT. | | 0.4 | | |
| 7 WEST DEERFIELD | 73 | 33 2056 | 3234. | 5.8 | 4.30 FT. | | 0.2 | | |
| 6 MONTAGUE CITY | 73 | 33 2056 | 21340. | 2.7 | 14.10 FT. | | 0.8 | | |
| 17 INDIAN ORCHARD | 72 | 33 2056 | 1500. | 2.2 | 6.10 FT. | | 0.0 | | |
| 18 WESTFIELD | 72 | 33 2056 | 1824. | 3.7 | 6.10 FT. | | -1.4 | | |
| 16 SPRINGFIELD | 72 | 33 2056 | 19600. | 2.0 | 5.60 FT. | | 0.2 | | |
| 27 MAD RIVER DAM | 63 | 33 2057 | | | | NO REPORT | | | |
| 24 COLLINSVILLE | 72 | 33 2057 | 9000. | 25.4 | 12.20 FT. | FSTG | 5.7 | | |
| 20 RAINBOW | 72 | 33 2057 | 2210. | 3.7 | 3.40 FT. | | 0.0 | | |
| 19 HARTFORD | 70 | 33 2057 | 20600. | 2.0 | 7.20 FT. | | 0.4 | | |
| 34 RUMNEY | 71 | 33 2057 | 387. | 2.7 | 3.50 FT. | | 0.1 | 15.67 IN. | 0.36 WARN |
| 33 WOODSTOCK | 72 | 33 2057 | 3946. | 20.4 | 6.70 FT. | WARN | 1.4 | 4.03 IN. | 0.37 WARN |
| 39 CAMPTON | 70 | 33 2057 | 422. | 7.3 | 10.80 FT. | | 0.3 | 2.65 IN. | 0.17 |
| 32 PLYMOUTH | 72 | 33 2057 | 3450. | 5.5 | 3.00 FT. | CHRG | 0.1 | | |
| 10 PENACOOK | 73 | 33 2057 | 3520. | 4.6 | 4.00 FT. | | 0.0 | | |
| 3 SOUCOOK | 69 | 33 2057 | 214. | 2.8 | 6.80 FT. | | 0.1 | | |
| 11 CONCORD | 73 | 33 2058 | 6190. | 2.6 | 5.30 FT. | | 0.1 | | |
| 8 GOFFSTOWN | 72 | 33 2058 | 782. | 7.5 | 5.70 FT. | | 1.1 | | |
| 9 GOFFS FALLS | 73 | 33 2058 | 6832. | 2.2 | 5.60 FT. | | -0.1 | | |
| 14 LOWELL | 73 | 33 2058 | 27499. | 5.9 | 48.20 FT. | | 0.1 | | |
| 96 | | | | | | | | | |
| 28 HALL MEADOW DAM | 72 | 33 2058 | 132. | 7.7 | 7.40 FT. | | 2.0 | | |
| 30 EAST BRANCH DAM | 71 | 33 2058 | 119. | 13.0 | 17.30 FT. | | 6.7 | 5.80 IN. | 0.22 |
| 26 THOMASTON DAM | 72 | 33 2058 | 996. | 10.2 | 26.80 FT. | | 11.9 | | |
| 31 NORTHFIELD BRK. LAKE | 72 | 33 2058 | 89. | 15.7 | 28.60 FT. | | 9.7 | | |
| 25 BLACK ROCK LAKE | 72 | 33 2058 | 345. | 15.2 | 39.10 FT. | | 9.1 | | |
| 23 HANCOCK BROOK LAKE | 72 | 33 2058 | 190. | 15.9 | 8.60 FT. | | 0.8 | | |
| 29 HOP BROOK LAKE | 72 | 33 2059 | 288. | 17.6 | 27.80 FT. | | 4.9 | | |
| 22 BEACON FALLS | 73 | 33 2059 | 6832. | 26.2 | 9.20 FT. | FSTG | 0.8 | | |
| 21 STEVENSON | 72 | 33 2059 | 15400. | 10.0 | 11.60 FT. | WARN | 2.5 | | |
| 99 | | | | | | | | | |
| 13 NORTHBRIDGE | 73 | 33 2059 | -0. | 0.0 | -10.00 FT. | NVLD1 | | | |
| 12 WOONSOCKET | 73 | 33 2059 | 2658. | 6.4 | 5.30 FT. | | 0.9 | | |
| 2 WEBSTER | 73 | 33 2059 | 574. | 6.7 | 6.60 FT. | WARN | 0.2 | | |
| 4 JEWETT CITY | 73 | 33 2059 | 4290. | 6.0 | 10.20 FT. | | 0.2 | | |
| 1 WILLIMANTIC NATCH.P. | 73 | 33 2059 | 3602. | 9.0 | 7.10 FT. | WARN | 1.2 | 14.06 IN. | 0.55 WARN |

# LOG OF RADIO REPORTS – FLOOD CONTROL DAMS

15 July 1977

WACHUSETT RELAY

| Line | ITEM | 66 WEST HILL | 54 LITTLE-VILLE | 53 KNIGHT-VILLE | 51 BIRCH HILL | 50 TULLY | 52 BARRE FALLS | 65 MANS-FIELD HOLLOW | 62 EAST BRIM-FIELD | 63 WEST-VILLE | 64 WEST THOMP-SON | 61 HODGES VILLAGE | 60 BUFFUM-VILLE | | | | | BUZZARDS BAY 24 NEW BEDFORD BARRIER | Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Time of Observation | 0800 | 0800 | 0800 | 0800 | 0800 | 0800 | 0800 | 0800 | 0800 | 0800 | 0800 | 0800 | | | | | | 1 |
| 2 | Precipitation (last 24 hrs.) | 0 | 0 | 0 | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | 2 |
| 3 | Form of Precipitation | - | - | - | - | - | - | - | - | - | - | - | - | | | | | | 3 |
| 4 | Present Weather | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | Clear | | | | | | 4 |
| 5 | Pool Stage | 2.18 | 518.83 | 2.4 | 1.825 | 15.0 | 777.97 | 17.15 | 13.29 | 10.57 | 15.66 | 3.02 | 11.02 | | | | | | 5 |
| 6 | Tendency | Steady | Falling | Falling | Steady | Rising | Steady | Steady | Rising | Steady | Steady | Rising | Steady | | | | | | 6 |
| 7 | Gate Openings | 3-0-3 | 3-3 | 3-3-3 | 4-4-4-4 | 0-.15 | 3-3 | F-.1-0-0-0 | 2-2-.1 | 0-F-.1 | .1-1-0 | 3-3 | .1-F-F | | | | | | 7 |
| 8 | Tailwater Gage | 1.37 | 2.00 | 2.87 | 4.15 | 2.76 | 2.37 | 2.1160 | 2.83 | 3.67 | 2.64 | 1.13 | 15 | | | | | | 8 |
| 9 | Outflow | 9 | 60 | 189 | 89 | 17 | 8 | 155 | 43 | 65 | 118 | 19 | | | | | | | 9 |
| 10 | INDEX POINTS | 4.1 | OUT | | 4.3 | | 3.54 | 3.1 | | | | 4.65 | | | | | | | 10 |
| 11 | | 526 | 4.3 | | | | 94 | 541 | | | | 36 | | | | | | | 11 |
| 12 | | 1.64 | 580 | | | | | | | | | | | | | | | | 12 |
| 13 | | 263 | | | | | | | | | | | | | | | | | 13 |
| 14 | | | | | | | | | | | | | | | | | | | 14 |
| 15 | | | | | | | | | | | | | | | | | | | 15 |

**REMARKS**

1 1/2" Alert

NED FORM OCT 75 477(A)

NED FORM 503 APR 65

# REGULATION OF Barre Falls AND RESERVOIRS

RCS NEDED-3

## LOG OF REPORTS AND INSTRUCTIONS

| DATE AND TIME OF REPORT | Barre Falls RES. RES POOL | | GATE OPENING | | | | | | | | OUTFLOW | | RES. RES POOL | | GATE OPENING | | | OUTFLOW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HOUR | STAGE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | T.W. | C.F.S. | HOUR | STAGE | 1 | 2 | 3 | T.W. | C.F.S. |
| 1977 | | | | | | | | | | | | | | | | | | | |
| 13Mar | 1715 | 776.2 | 1.5 | 1.5 | | | | | | | 3.98 | 280 | | | | | | | |
| 14Mar | 0815 | 779.8 | 1.5 | 1.5 | | | | | | | 4.25 | 375 | | | | | | | |
| | GO | TO | .5 | .5 | | | | | | | | | | | | | | | |
| | 1300 | 781.7 | .5 | .5 | | | | | | | 3.47 | 135 | | | | | | | |
| | GO | TO | 1 | 1 | | | | | | | | | | | | | | | |
| | 1500 | 782.3 | 1 | 1 | | | | | | | 3.97 | 275 | | | | | | | |
| 15Mar | 0800 | 785.6 | 1 | 1 | | | | | | | 4.07 | 310 | | | | | | | |
| | GO | TO | 2 | 2 | | | | | | | | | | | | | | | |
| | 1500 | 786.2 | 2 | 2 | | | | | | | 4.77 | 625 | | | | | | | |
| | GO | TO | 3 | 3 | | | | | | | | | | | | | | | |
| 16Mar | 0800 | 786.0 | 3 | 3 | | | | | | | 5.23 | 915 | | | | | | | |
| 17Mar | 0800 | 785.2 | 3 | 3 | | | | | | | 5.22 | 890 | | | | | | | |
| 18Mar | 0800 | 783.7 | 3 | 3 | | | | | | | 5.15 | 860 | | | | | | | |
| | 1500 | 782.9 | 3 | 3 | | | | | | | 5.08 | 813 | | | | | | | |

| DATE AND TIME OF REPORT | PRECIPITATION | | INCHES | | Ware RIVER AT Barre Plains | | | Chicopee RIVER AT Indian Orchard | | | RIVER AT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LOCATION | HOUR | INC | ACC. | HOUR | STAGE | C.F.S | HOUR | STAGE | C.F.S | HOUR | STAGE | C.F.S | HOUR | STAGE | C.F.S |
| 1977 | | | | | | | | | | | | | | | | |
| 13Mar | Barre Falls | 1715 | 1.25 | 1.25 | 1715 | 3.4 | | 1715 | 9.12 | 4888 | | | | | | |
| 14Mar | Barre Falls | 0815 | 0.5 | 1.75 | 0815 | 3.5 | | 0815 | 9.22 | 5028 | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | 1300 | 3.4 | | 1300 | 9.11 | 4874 | | | | | | |
| | | | | | | | | | | | | | | | | |
| | Barre Falls | 1500 | 0.15 | 1.90 | 1500 | 3.4 | | 1500 | 9.07 | 4818 | | | | | | |
| 15Mar | Barre Falls | 0800 | 0.35 | 2.25 | 0800 | 3.3 | | 0800 | 8.97 | 4681 | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | 1500 | 3.0 | | 1500 | 8.71 | 4343 | | | | | | |
| | | | | | | | | | | | | | | | | |
| 16Mar | | | | | 0800 | 2.8 | | 0800 | 7.86 | 3282 | | | | | | |
| 17Mar | Barre Falls | 0800 | 0.15 | 2.40 | 0800 | 2.7 | | 0800 | 7.34 | 2704 | | | | | | |
| 18Mar | | | | | 0800 | 2.5 | | 0800 | 6.96 | 2270 | | | | | | |
| | Barre Falls | 0800 | 0.08 | 2.48 | 1500 | 2.4 | | 1500 | 6.80 | 2150 | | | | | | |

END OF OPERATION

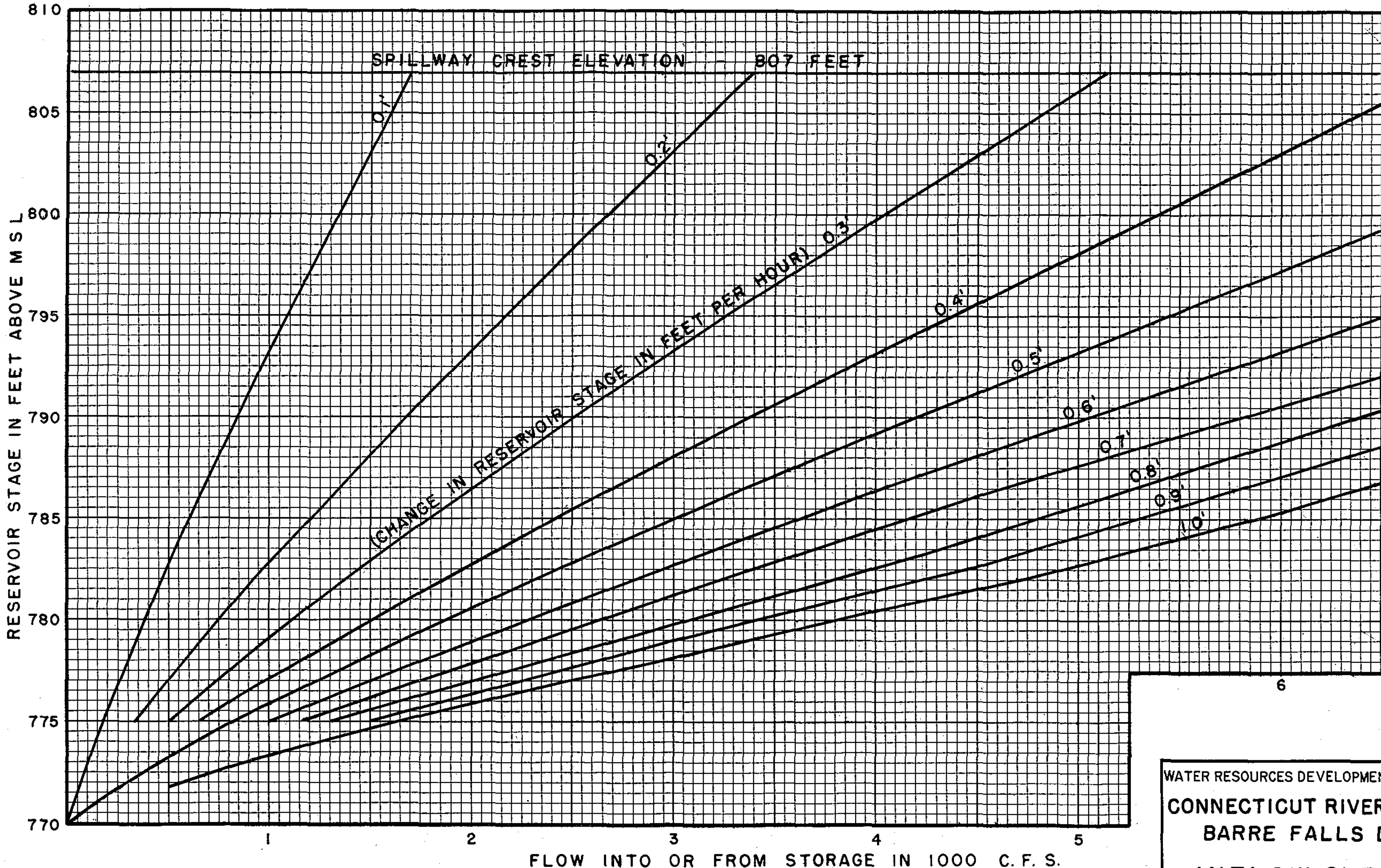
ED FORM 102
Nov. 1951

RESERVOIR REGULATION
COMPUTATION OF INFLOW

Flood of APRIL 1960

Reservoir BARRE FALLS DAM By ______ Date APRIL 1960

| TIME | RES. STAGE Feet | CHANGE IN RES. STAGE Feet per hour Observed | CHANGE IN RES. STAGE Feet per hour Adjusted | FLOW into/from STORAGE c.f.s. | OUTFLOW c.f.s. | TOTAL INFLOW (5) + (6) c.f.s. | REMARKS |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 31 Mar | | | | | | | |
| 0800 | 777.39 | | | | 221 | | |
| | | 0.46 | 0.23 | 600 | | 821 | |
| 1000 | 777.85 | | | | 90 | | |
| | | 0.79 | 0.39 | 1100 | | 1190 | |
| 1200 | 778.64 | | | | 90 | | |
| | | 0.56 | 0.28 | 950 | | 1040 | |
| 1400 | 779.20 | | | | 90 | | |
| | | 0.50 | 0.25 | 850 | | 940 | |
| 1600 | 779.70 | | | | 95 | | |
| | | 0.50 | 0.25 | 900 | | 995 | |
| 1800 | 780.20 | | | | 95 | | |
| | | 0.60 | 0.30 | 1000 | | 1095 | |
| 2000 | 780.80 | | | | 95 | | |
| | | 0.50 | 0.25 | 1050 | | 1145 | |
| 2200 | 781.30 | | | | 95 | | |
| | | 0.50 | 0.25 | 1080 | | 1175 | |
| 2400 | 781.80 | | | | 95 | | |
| 1 April | | 0.50 | 0.25 | 1130 | | 1225 | |
| 0200 | 782.30 | | | | 95 | | |
| | | 0.50 | 0.25 | 1200 | | 1295 | |
| 0400 | 782.80 | | | | 95 | | |
| | | 0.50 | 0.25 | 1250 | | 1345 | |
| 0600 | 783.30 | | | | 95 | | |
| | | 0.46 | 0.23 | 1200 | | 1295 | |
| 0800 | 783.76 | | | | 100 | | |
| | | 0.47 | 0.23 | 1250 | | 1350 | |
| 1000 | 784.23 | | | | 100 | | |
| | | 0.46 | 0.23 | 1330 | | 1430 | |
| 1200 | 784.69 | | | | 125 | | |
| | | 0.42 | 0.21 | 1400 | | 1525 | |
| 1400 | 785.11 | | | | 150 | | |




BOTTOM OF RESERVOIR - ELEV. 770 FT.
INVERT - ELEV. 761 FT.

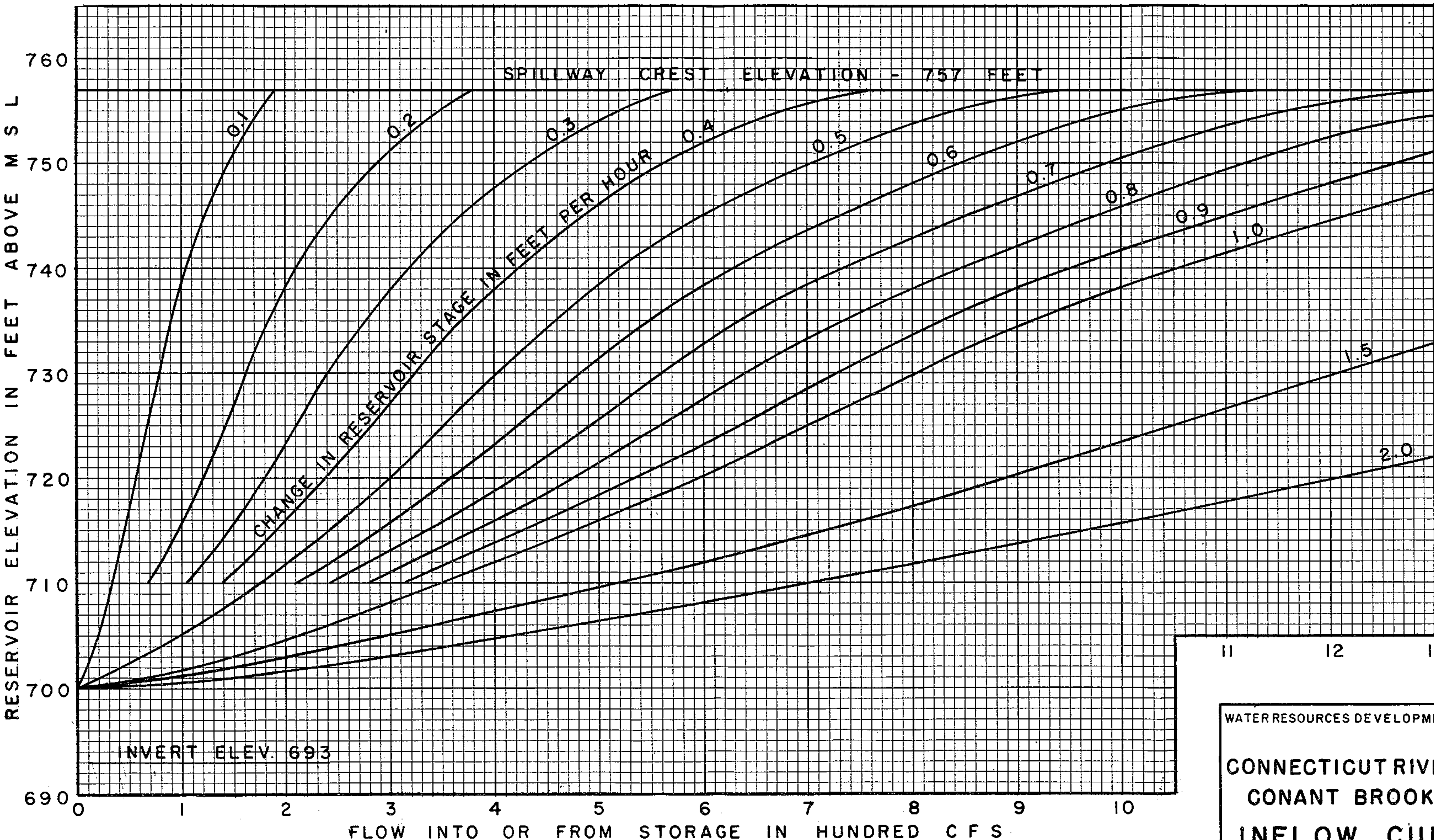
NOTE: INVERT ELEVATION = 761 DUE TO 9-FOOT DROP AT INLET CHANNEL.

WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
BARRE FALLS DAM

# INFLOW CURVES

NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978




WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
CONANT BROOK DAM

## INFLOW CURVES

NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978

# GATE OPERATION RECORD

Barre Falls RESERVOIR March MONTH 77 YEAR

OPERATOR

| I.D. | DAY | HOUR | RES. STAGE | OUTFLOW | PRECIP. | T. W. | GATE SETTING 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 | 0800 | 774.83 | 264 | . | 393 | 1.5 | 1.5 | | | | | | | |
| | 14 | 0800 | 779.80 | 317 | 1.75 | 4.09 | 1.5 | 1.5 | | | | | | | Gate Change |
| | 14 | 1300 | 781.70 | 135 | . | 3.47 | .5 | .5 | | | | | | | Gate Change |
| | 14 | 1500 | 782.30 | 236 | . | 3.84 | 1 | 1 | | | | | | | |
| | 15 | 0800 | 785.60 | 251 | . | 3.89 | 1 | 1 | | | | | | | Gate Change |
| | 15 | 1500 | 786.20 | 485 | . | 4.50 | 2 | 2 | | | | | | | Gate Change |
| | 16 | 0800 | 786.20 | 629 | . | 4.78 | 3 | 3 | | | | | | | |
| | 17 | 0800 | 785.20 | 624 | . | 4.77 | 3 | 3 | | | | | | | |
| | 18 | 0800 | 783.70 | 570 | . | 4.67 | 3 | 3 | | | | | | | Gate Change |
| | 18 | 1500 | 782.90 | 815 | . | 5.09 | 4 | 4 | | | | | | | |
| | 19 | 0800 | 780.18 | 730 | .35 | 4.96 | 4 | 4 | | | | | | | |
| | 20 | 0800 | 772.76 | 331 | . | 4.13 | 4 | 4 | | | | | | | |
| | 21 | 0800 | 772.55 | 267 | . | 3.94 | 4 | 4 | | | | | | | Gate Change |
| | 22 | 0800 | 772.50 | 215 | . | 3.87 | 2 | 2 | | | | | | | |

NED FORM SEP 70 90 REPLACES EDITION OF MAR 62 WHICH IS OBSOLETE

# STANDARD OPERATING PROCEDURE (SOP)
## FLOOD CONTROL REGULATION
## BARRE FALLS DAM

| PHASE | STORM RAINFALL (WITHIN 24-HR. PERIOD) ANTECEDENT CONDITIONS: SNOW-COV'R'D WET OR FROZEN GROUND | STORM RAINFALL: DRY GROUND | BARRE FALLS DAM: RISING POOL STAGE FEET | RIVER INDEX STATIONS (STAGE IN FEET): WARE RIVER AT COLDBROOK (MDC INTAKE) (97 SQ. MI.) | WARE RIVER AT BARRE PLAINS (RTE 32 HWY BRIDGE) (115 SQ. MI.) | CHICOPEE RIVER AT INDIAN ORCHARD (USGS GAGE) (688 SQ. MI.) | CONNECTICUT RIVER AT MONTAGUE CITY (USGS GAGE) (7,865 SQ. MI.) | CONNECTICUT RIVER AT SPRINGFIELD (NWS) (9,587 SQ. MI.) | REGULATION INSTRUCTIONS: GATE SETTINGS BARRE FALLS DAM |
|---|---|---|---|---|---|---|---|---|---|
| I - APPRAISAL | | | | | | | | | |
| FIRST ALERT | 1.0" | 1.0" | SUMMER 776' MSL<br>WINTER 780' MSL | — | — | — | | | 2'-2' |
| SECOND ALERT | 1.5" | 2.0" | As Instructed | — | — | — | | | |
| | (Or As Instructed) | | | | | | | | |
| INITIAL REGULATION | 2.0" | 3.0" | As Instructed | — | GROWING SEASON 1.5<br>NON-GROWING 3.5 | 8.0 (3450 CFS) | | | BOTH GATES CLOSED TO 1-FOOT GATE SETTINGS |
| | (Or As Instructed) | | | | | | | | |
| II - CONTINUATION OF REGULATION | 3.0" | 4.0" | As Instructed | — | GROWING SEASON 2.0<br>NON-GROWING 4.0 | 10.0 (6160 CFS) | 26 (68,800 CFS) | 18 (126000 CFS) | RESTRICT OUTFLOW TO MINIMUM RELEASES (0.1'-0) |
| | (Or As Instructed) | | | | | | | | |
| III - EMPTYING THE RESERVOIRS | STORM HAS ABATED | | NONDAMAGING DOWNSTREAM CHANNEL CAPACITY FOR BARRE FALLS IS 1000± CFS DURING NON-GROWING SEASON, 600± CFS DURING GROWING SEASON | | | | | | |

### DUTIES DURING EACH PHASE

**FLOOD CONTROL PROJECT MANAGER**

PHASE I
1. COLLECT AND TRANSMIT RAINFALL AND STAGE DATA TO RCC.
2. OPERATE ACCORDING TO INSTRUCTIONS FROM RCC.

PHASE II
1. OPERATE ACCORDING TO INSTRUCTIONS FROM RCC.
2. NOTE ALL UNUSUAL CONDITIONS AT DAM, DOWNSTREAM CHANNELS AND INDEX STATIONS.
3. COLLECT AND TRANSMIT RAINFALL AND STAGE DATA AT MINIMUM 3-HOUR INTERVALS OR AS DIRECTED BY RCC.

PHASE III
1. CONTINUE PHASE II, STEP 3.
2. RECONNOITER DOWNSTREAM CHANNELS AND POTENTIAL DAMAGE AREAS.
3. REPORT TO RCC FOR FURTHER INSTRUCTIONS.

**PROJECT REGULATOR**

PHASE I
1. COMPILE DATA.
2. PLAN AND COORDINATE NEXT TRANSMISSION TO PROJECT MANAGERS.
3. RESTRICT OUTFLOW TO MAINTAIN SAFE DOWNSTREAM CHANNEL CAPACITIES.
4. INFORM CONNECTICUT RIVER BASIN REGULATOR OF ACTIONS.

PHASE II
1. CONTINUE REGULATION INSTRUCTIONS TO PROJECT MANAGERS.
2. CONSULT WITH BASIN REGULATOR TO ANALYZE SEVERITY OF FLOOD.
3. COORDINATE REGULATION WITH CONNECTICUT RIVER BASIN REGULATOR.

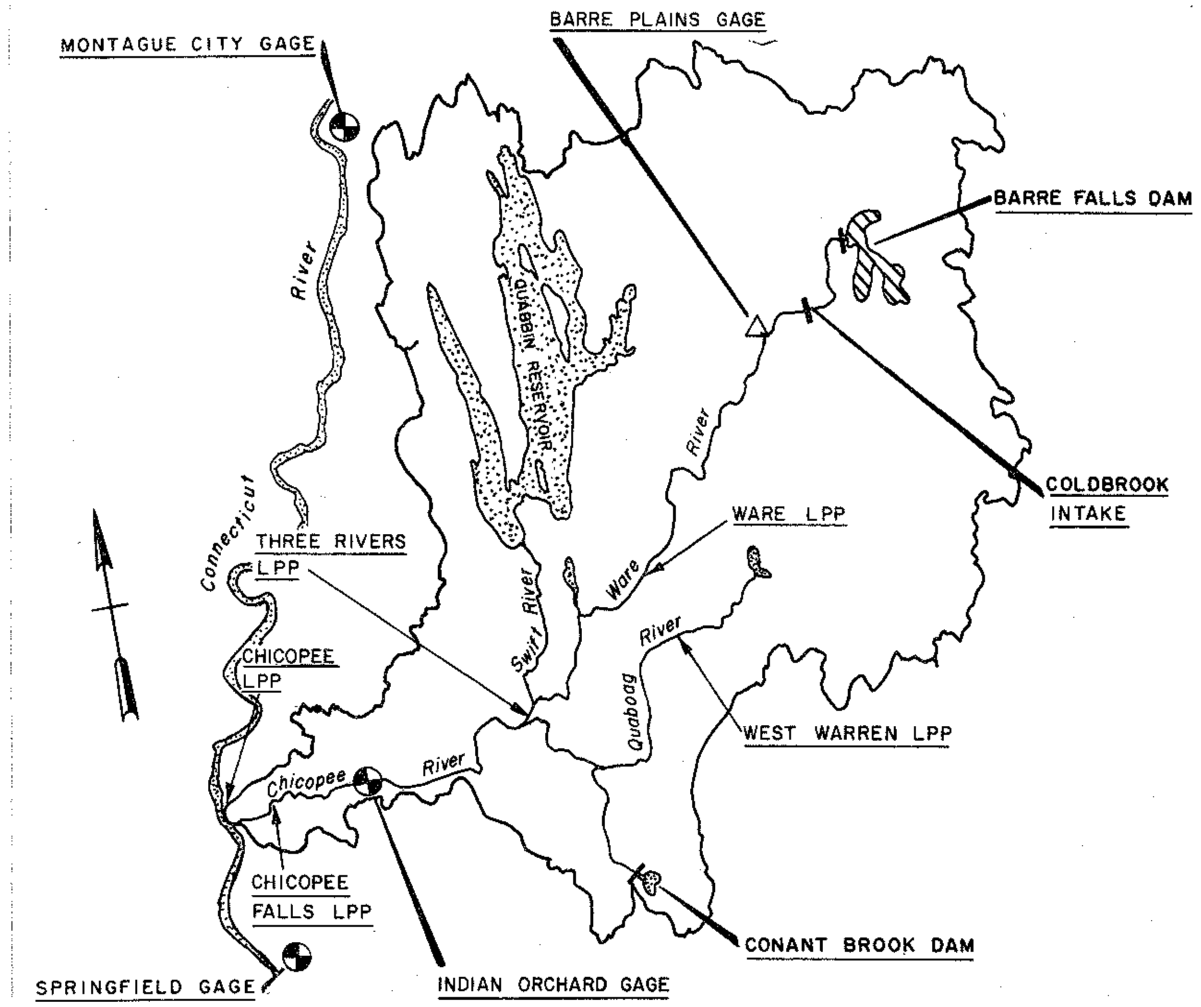
PHASE III
1. COLLECT DATA FROM PROJECT MANAGERS.
2. CONSULT WITH CONNECTICUT RIVER BASIN REGULATOR.
3. TRANSMIT INSTRUCTIONS TO PROJECT MANAGERS.

### EMERGENCY OPERATION PROCEDURE (EOP)
(During Communications Failure with RCC)

| | Partial Closure 1' - 1' | Complete Closure 0 - 0.1' |
|---|---|---|
| Rainfall in 24 hour Period | 2.0" | 3.0" |
| **Rising Stages** | | |
| Barre Plains | 1.5' | 2.0' |
| Indian Orchard | 8.0' | 9.0' |

Notes:

1. Emptying the reservoir shall not be initiated until contact has been established with RCC.
2. The rate of discharge shall not exceed 150 cfs/hour up to 600 cfs and 50 cfs/hour over 600 cfs.
3. Maximum rate of reservoir drawdown at Barre Falls should not exceed 5 feet/24 hours.
4. Refer to Paragraph 26 for regulation at Barre Falls while Coldbrook Diversion is operating.
5. Reservoir roads should be barricaded when a rising pool is expected to exceed 783.5 ft. MSL.
6. Following is a list of legal diversion criteria at the Coldbrook Diversion:
   a. No Diversion is allowed between 15 June and 15 October.
   b. All flows in excess of 132 cfs from 15 Oct. to 1 Dec. with permission of the Mass. Dept. of Public Health.
   c. All flows in excess of 132 cfs from 1 December to 31 May.
   d. All flows in excess of 132 cfs from 31 May to 15 June with permission of the Mass. Dept. of Public Health.



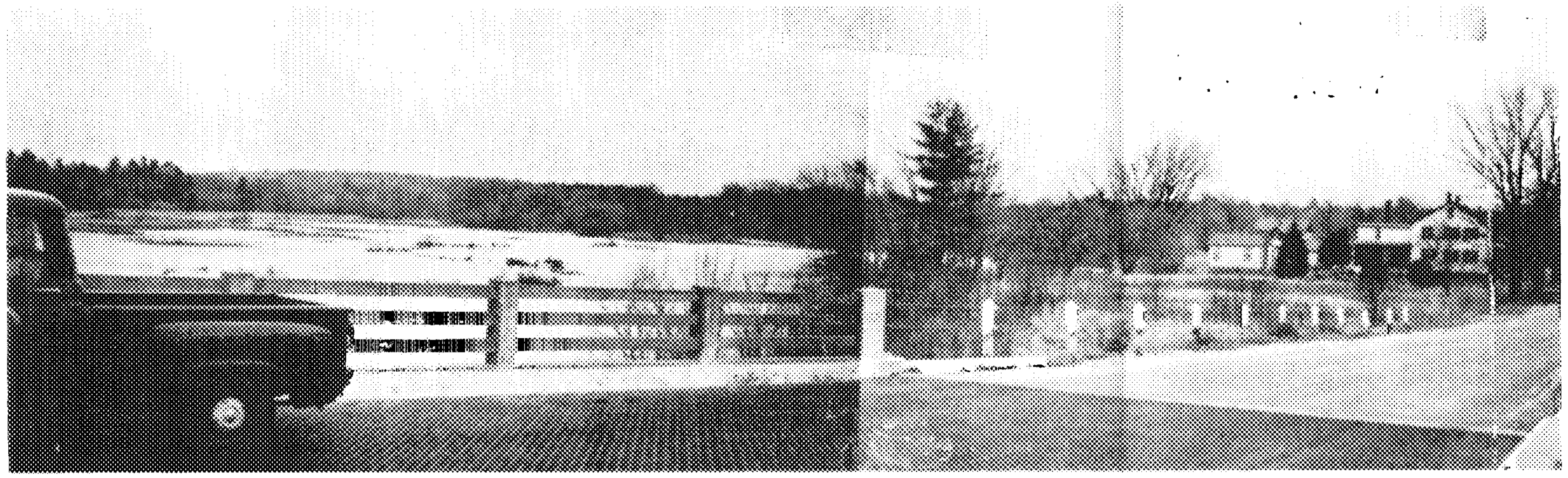

**LEGEND**

- USGS GAGE
- STAFF GAGE

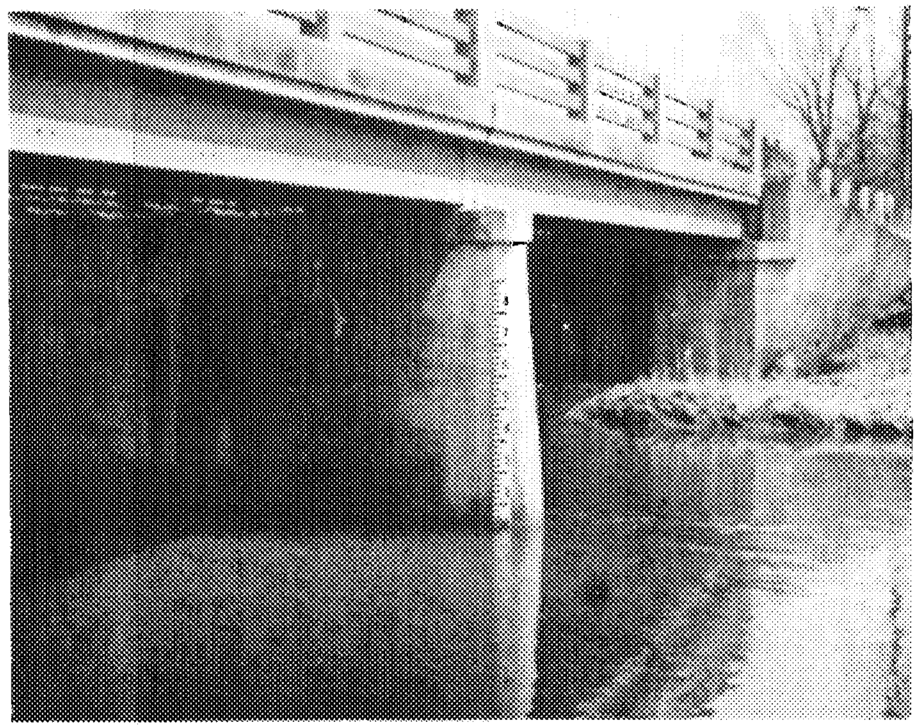
**AVERAGE PEAK TRAVEL TIME**

| | |
|---|---|
| BARRE FALLS DAM TO COLDBROOK INTAKE | 3-4 HOURS |
| BARRE FALLS DAM TO BARRE PLAINS | 5-7 HOURS |
| BARRE FALLS DAM TO THREE RIVERS | 18-20 HOURS |
| BARRE FALLS DAM TO THE MOUTH OF THE CHICOPEE | 22-26 HOURS |

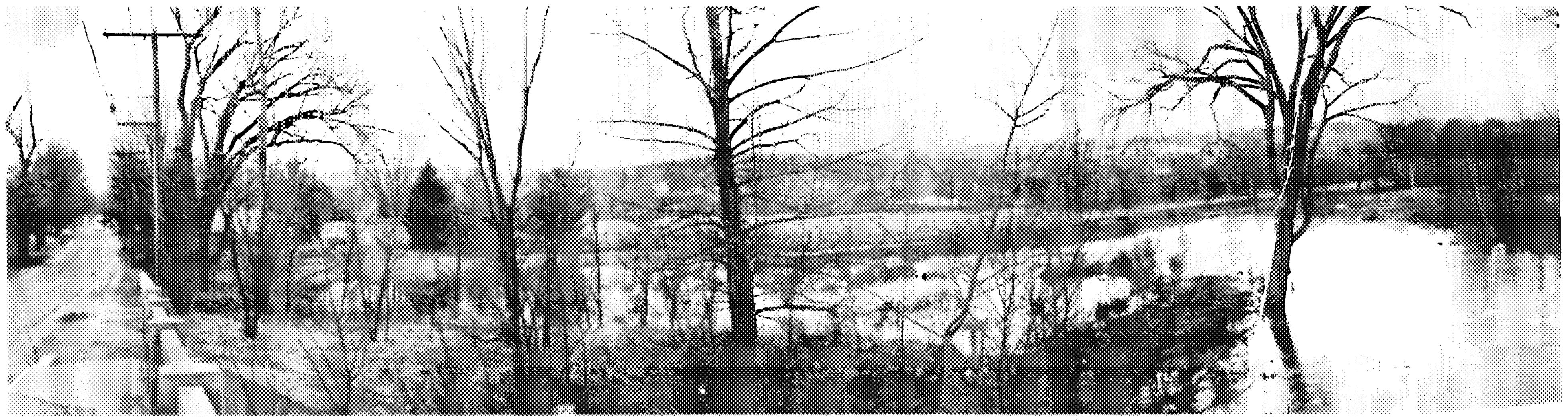
# WARE RIVER AT BARRE PLAINS



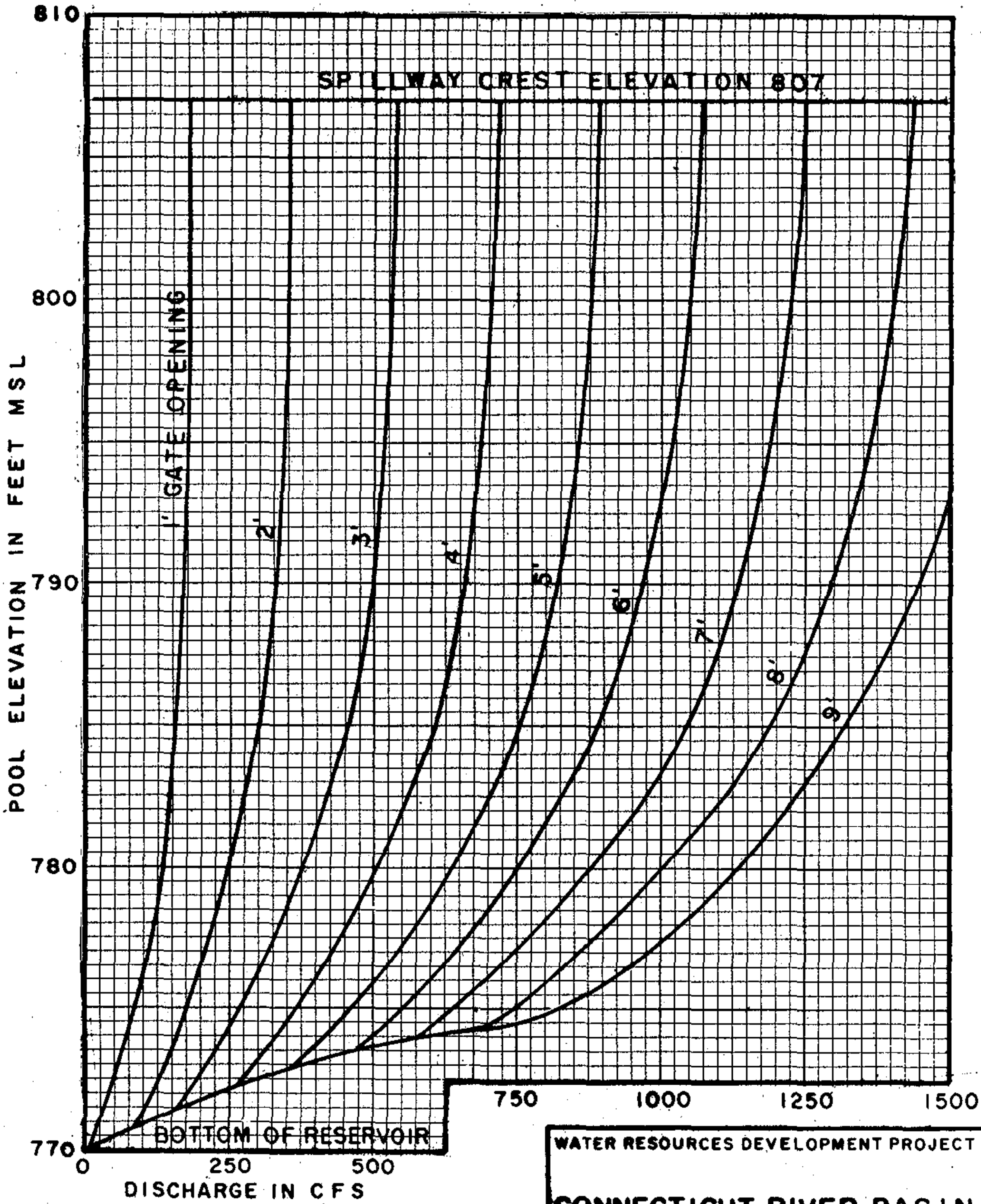
LOOKING UPSTREAM



WARE RIVER AT BARRE PLAINS
STAFF GAGE



LOOKING DOWNSTREAM BARRE PLAINS (RT. 32 BRIDGE)




NOTE:

TWO FLOOD CONTROL GATES EACH 4.5 FEET WIDE x 9 FEET HIGH.

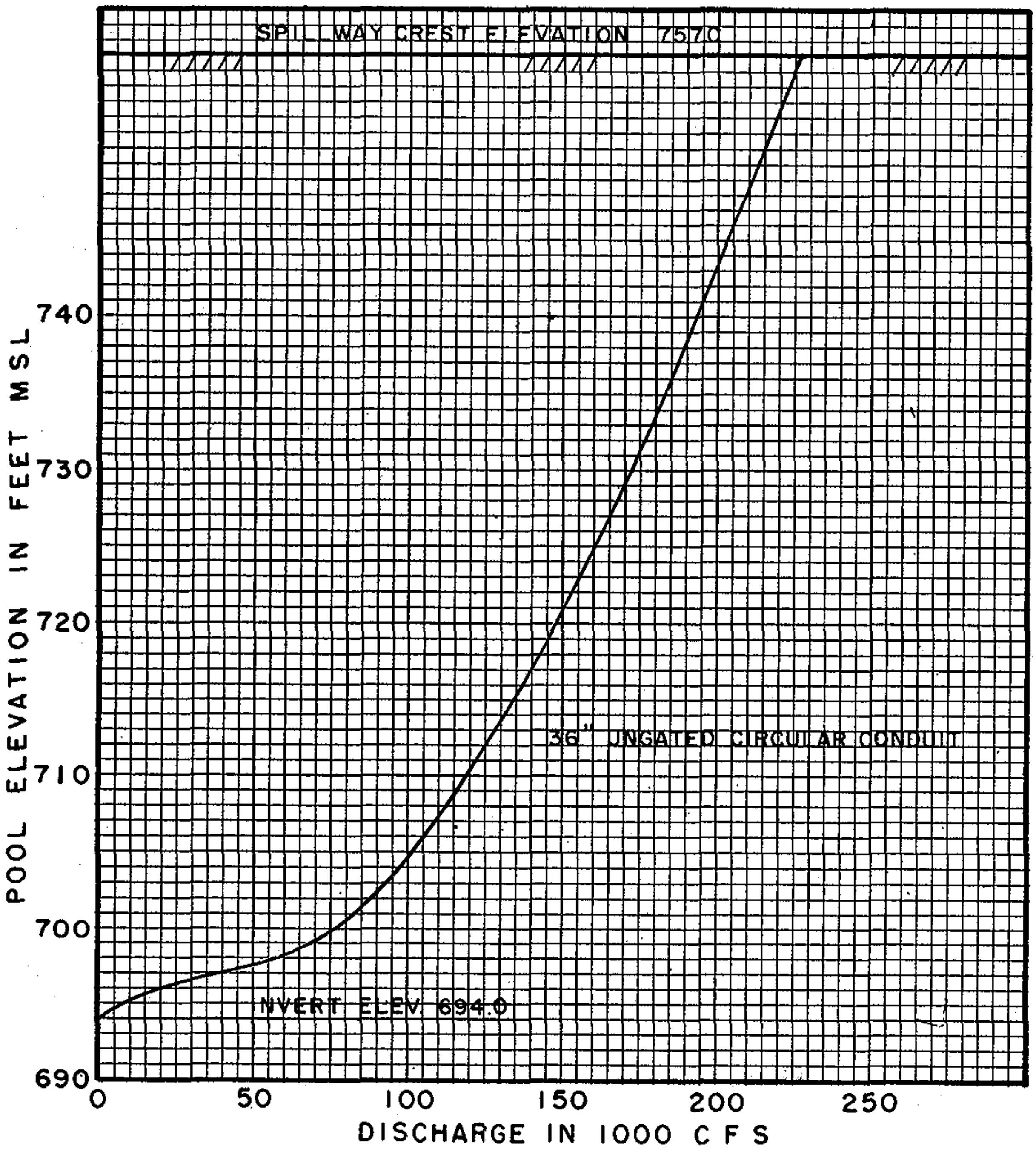
WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN

BARRE FALLS DAM

OUTLET RATING CURVE FOR ONE GATE

NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPTEMBER 1978



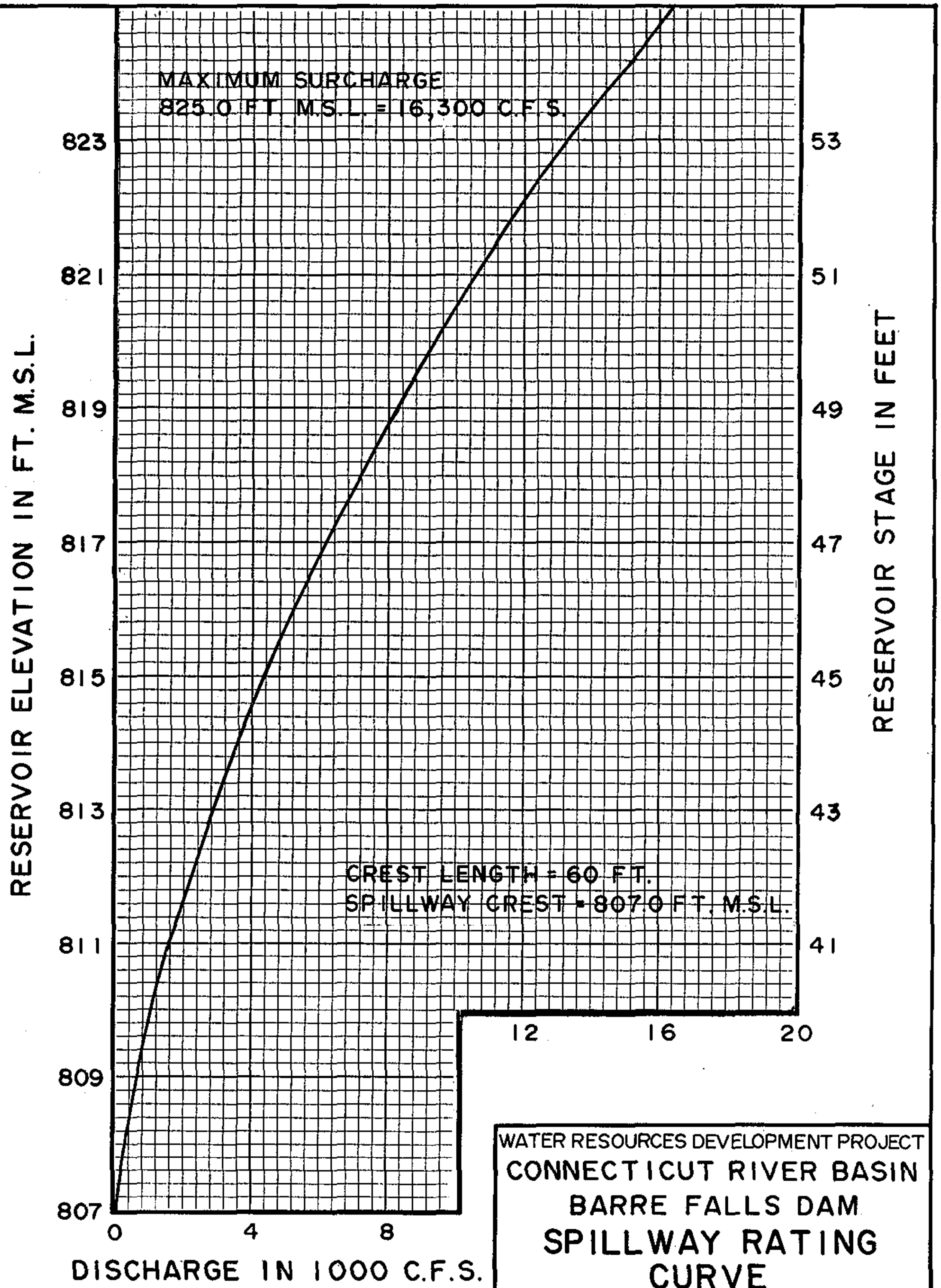

WATER RESOURCES DEVELOPMENT PROJECT

CONNECTICUT RIVER BASIN
CONANT BROOK DAM

OUTLET RATING CURVE

NEW ENGLAND DIVISION, WALTHAM, MASS.
SEPT. 1978

PLATE G-57

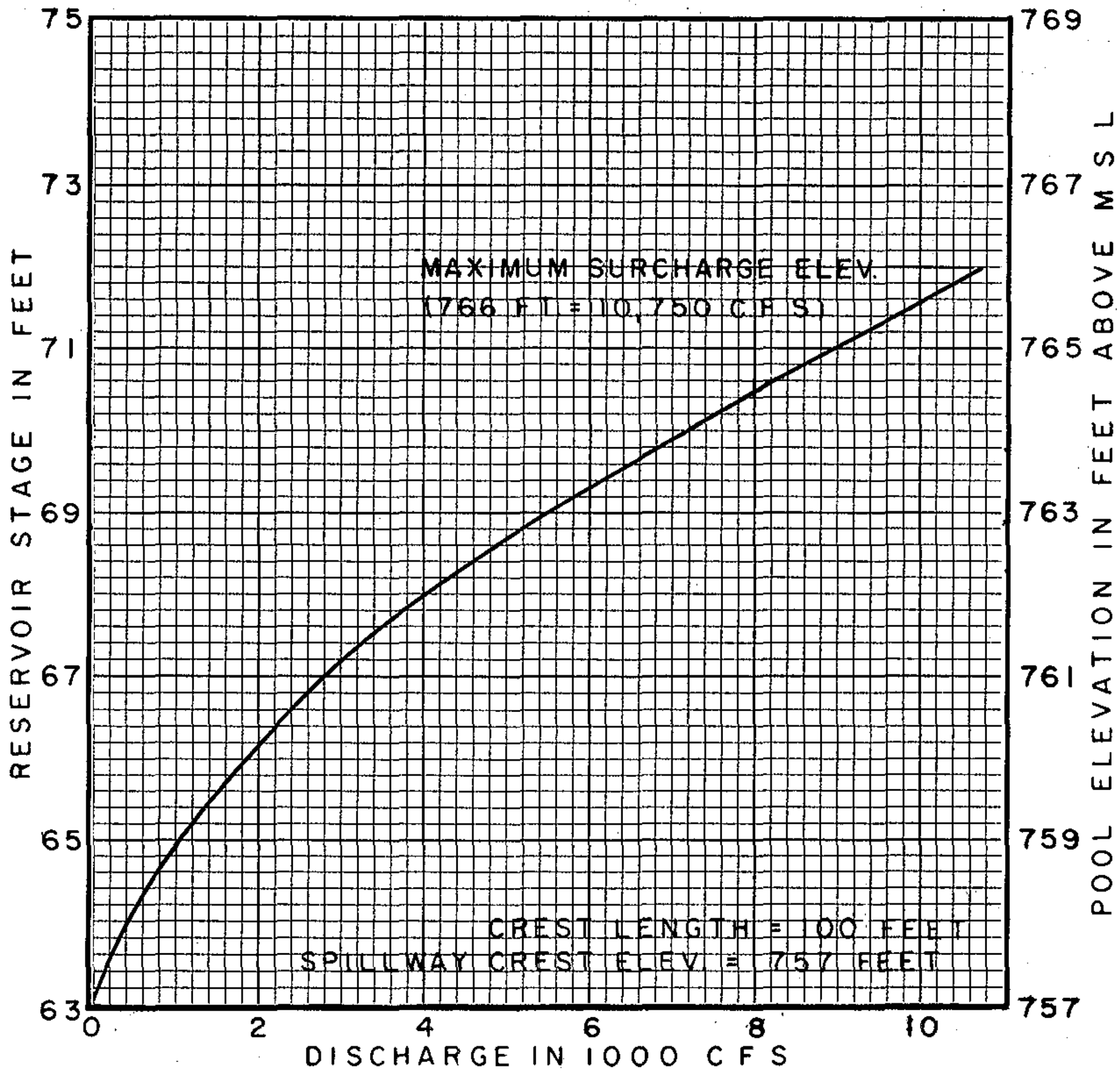



WATER RESOURCES DEVELOPMENT PROJECT
CONNECTICUT RIVER BASIN
BARRE FALLS DAM

# SPILLWAY RATING CURVE

NEW ENGLAND DIVISION, WALTHAM, MASS.
AUGUST 1978

PLATE G-58




WATER RESOURCES DEVELOPMENT PROJECT
CONNECTICUT RIVER BASIN
CONANT BROOK DAM
SPILLWAY RATING CURVE
NEW ENGLAND DIVISION, WALTHAM, MASS.
MAY 1978

PLATE G-60

VIEW OF BARRE FALLS DAM

VIEW OF CONANT BROOK DAM

PLATE G-61